TM 8-6515-003-24&P

TECHNICAL MANUAL

UNIT, DIRECT SUPPORT, AND GENERAL SUPPORT MAINTENANCE MANUAL

(INCLUDING REPAIR PARTS AND SPECIAL TOOLS LIST)

ELECTROSURGICAL APPARATUS
MODEL FORCE 2

6515-01-309-6647

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED

HEADQUARTERS, DEPARTMENT OF THE ARMY

1993

SAFETY STEPS TO FOLLOW IF SOMEONE IS THE VICTIM OF ELECTRICAL SHOCK

Do not try to pull or grab the individual.

If possible, turn off the electrical power.

If you cannot turn off the electrical power, pull, push, or lift the person to safety using a dry wooden pole or a dry rope, or some other insulating material.

Send for help as soon as possible.

After the injured person is free of contact with the source of electrical shock, move the person a short distance away and immediately start artificial resuscitation.

Throughout this manual are WARNINGS, CAUTIONS, and NOTES. Please take time to read these. They are there to protect you and the equipment.

WARNING

Procedures which must be observed to avoid personal injury, and even loss of life.

CAUTION

Procedures which must be observed to avoid damage to equipment, destruction of equipment, or long-term health hazards.

NOTE

Essential information that should be remembered.

ELECTRICAL AND ELECTRONIC HAZARDS

» Severe injury or death can result when any part of your body comes in contact with live electrical circuits. Medical Equipment Repairers must be especially alert to the dangers of exposed circuits, terminals, power panels, and the like.

» The electrical parameter that injures and kills is CURRENT; the force that caused current to flow is called VOLTAGE. Voltage ratings are normally assigned to live electrical circuits, power supplies, and transmission lines. You should consider all voltages of 30 or more to be hazardous.

» The physiological effect of current flowing through the human body is related to the following factors:

- The path of the current through the body.
- The magnitude of the current.
- The duration of the voltage shock or discharge that causes current flow.
- The frequency of the voltage if alternating current.
- The susceptibility of damage to your heart from the current and from repeated shocks.

» Alternating current tends to concentrate near the body's surface because of the phenomenon of "skin effect." The higher the frequency of the alternating current voltage source, the more likely the current will tend to flow in or near the skin and away from internal body organs.

» The effect of current becomes more severe with the length of time that it flows through the body; a prolonged current flow can cause severe internal burns, collapse, unconsciousness, or death.

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ELECTROSURGICAL APPARATUS MODEL FORCE 2

6515-01-309-6647

You can help improve this manual. If you find any mistakes or if you know a way to improve procedures, please let us know. Mail your memorandum, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 (Recommended Changes to Equipment Technical Publications) located in the back of this manual, to: Commander, U.S. Army Medical Materiel Agency, ATTN: SGMMA-M, Frederick, MD 21702-5001. A reply will be furnished directly to you.

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HOW TO USE THIS MANUAL

This manual provides all the information needed to understand the capabilities, functions, and characteristics of this equipment. It describes how to set up, operate, test, and repair the equipment. You must familiarize yourself with the entire manual before operating or beginning a maintenance task.

The manual is arranged by chapters, sections, and paragraphs followed by appendixes, a glossary, an index, and DA Forms 2028-2. Use the table of contents to help locate the chapter or section for the general subject area needed. The index will help locate more specific subjects.

Multiple figures and tables are provided for your ease in using this manual. Words or terms that you will actually see on the equipment are represented in the text as closely as possible. Terms, symbols, and numbers that you will actually see in the control module displays will be in quotation marks.

Chapter 3 provides a systematic method of inspecting and servicing the equipment. In this way, small defects can be detected early before they become a major problem causing the equipment to fail. Make a habit of doing the checks and services in the same order each time and anything wrong will be detected quickly.

Specific direct support and general support maintenance instructions are included. Only perform maintenance functions specified in the maintenance allocation chart for your level of maintenance. Maintenance functions specified for higher levels of maintenance frequently require additional training; test, measurement, and diagnostic equipment; or tools.

DRAFT

CHAPTER 1

INTRODUCTION

Section I. GENERAL INFORMATION

1-1. Overview.

This manual describes the electrosurgical (ES) apparatus (fig 1-1); provides equipment technical data; and provides operational and maintenance functions, services, and actions. Additional information follows:

a. Type of manual. Unit, direct support (DS), and general support (GS) maintenance (including repair parts and special tools list).

b. Model number and equipment name. Model number Force 2, Electrosurgical Apparatus.

c. Purpose of equipment. To provide an alternative to the mechanical scalpel for cutting tissue. The advantages of an ES apparatus include simultaneous cutting and coagulation (hemostasis), easier access to some surgical sites, and heat destruction of cells at the operative site, which may help to minimize the risk of spreading diseased cells.

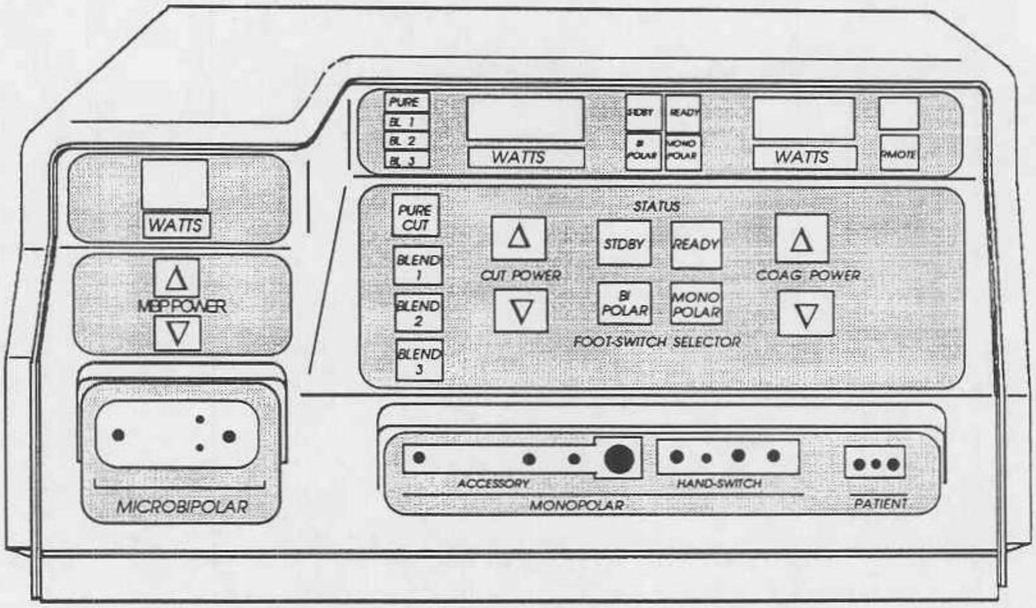

PURE
BL 1
BL 2
BL 3
WATTS
STDBY
READY
BI POLAR
MONO POLAR
WATTS
RMOTE
WATTS
MBP POWER
PURE CUT
BLEND 1
BLEND 2
BLEND 3
STATUS
CUT POWER
STDBY
READY
BI POLAR
MONO POLAR
COAG POWER
FOOT-SWITCH SELECTOR
MICROBIPOLAR
ACCESSORY
HAND-SWITCH
MONOPOLAR
PATIENT

Figure 1-1. Electrosurgical apparatus.

1-2. Explanation of abbreviations and terms.

Special or unique abbreviations, acronyms, and terms used within this manual are explained in the glossary.

1-3. Maintenance forms, records, and reports.

TB 38-750-2 prescribes forms, records, reports, and procedures.

1-4. Destruction of Army materiel to prevent enemy use.

AR 40-61 contains instructions for destruction and disposal of Army medical materiel. Also, the SB 8-75 series provides periodic information and/or instructions on the destruction of medical materiel.

1-5. Administrative storage.

a. Place the ES apparatus in administrative storage for only short periods of time when a shortage of maintenance effort exists. This equipment should be in mission readiness condition within 24 hours or within the time factors determined by the directing authority. During the storage period, keep appropriate maintenance records.

b. Perform preventive maintenance checks and services (PMCS) listed in tables 3-1 and 3-2 before placing Army equipment in administrative storage. When equipment is removed from storage, perform PMCS to ensure its operational readiness.

c. Inside storage is preferred for equipment selected for administrative storage.

1-6. Preparation for storage or shipment.

Procedures to prepare the ES apparatus for storing or shipping are listed in chapter 3, section X.

1-7. Quality assurance or quality control (QA or QC).

TB 740-10/DLAM 4155.5/AFR 67-43 contains QA or QC requirements and procedures.

1-8. Nomenclature cross-reference list.

Table 1-1 identifies official versus commonly used nomenclatures.

Table 1-1. Nomenclature cross-reference list.

Common name	*Official nomenclature*
CUT	Tissue cutting
COAG	Tissue coagulation
ES apparatus	Electrosurgical apparatus
Handswitching pencil	Handle, electrode
Keyboard switch	Membrane switch
Monopolar footswitch	Switch, foot, ES apparatus
Shipping/storing chest	Case, medical, transit and storage

NOTE

The manufacturer also refers to the ES apparatus as a "generator."

This manual also refers to the monopolar display/control (MD/C) printed circuit board (PCB) as the central processing unit (CPU).

1-9. Reporting and processing medical materiel complaints and/or quality improvement reports.

AR 40-61 prescribes procedures for submitting medical materiel complaints and/or quality improvement reports for the ES apparatus.

1-10. Warranty information.

A warranty is not applicable.

Section II. EQUIPMENT DESCRIPTION AND DATA

1-11. Equipment characteristics, capabilities, and features.

a. The ES apparatus is a self-contained portable unit which may be placed on its mobile cart or any sturdy table for use. It is a solid state, microprocessor-controlled apparatus with self-test capability. The front panel controls and indicators allow operation in multiple modes with variable power levels.

b. The ES apparatus operates from multiple voltages and frequencies.

c. The ES apparatus includes a chest, a canvas case, footswitches, and other operating accessories and supplies.

1-12. Component descriptions.

a. Mobile cart (fig 1-2). The mobile cart consists of a base assembly with shelves, four casters, and an adjustable position top for mounting the ES apparatus.

b. Footswitches. The monopolar (fig 1-3) and bipolar (fig 1-4) footswitches are made of heavy cast metal. Both footswitches are explosion proof and splash proof. The attached cable assembly on each footswitch is 10 feet long. Pedals on the monopolar footswitch are labeled for "CUT" and "COAG" activation. The monopolar footswitch also has protective guards to prevent accidental depression.

NOTE

In electrosurgery, CUT and COAG are terms to identify the voltage waveform and ES apparatus output and their specific functions.

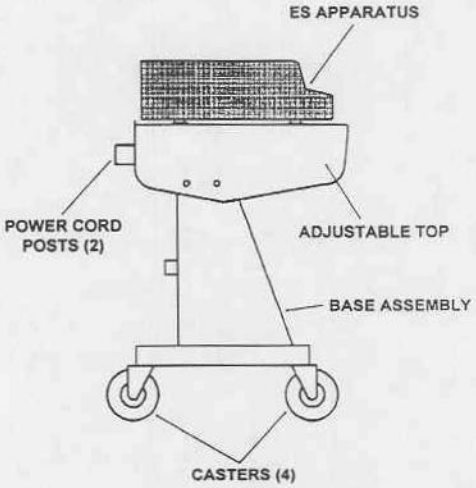


Figure 1-2. Mobile cart.

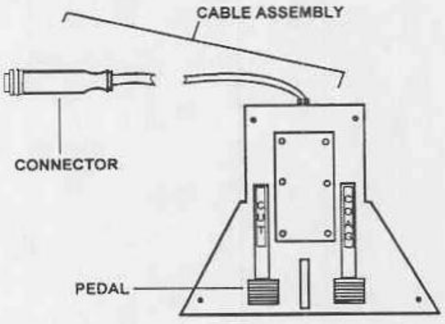


Figure 1-3. Monopolar footswitch.

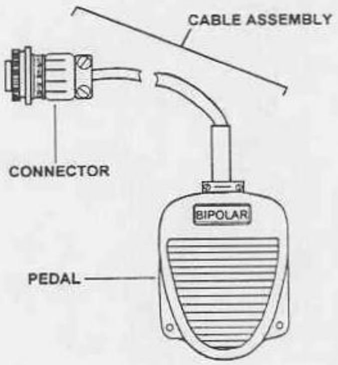


Figure 1-4. Bipolar footswitch.

c. Chest (fig 1-5). The chest, with polyurethane cushioning material, provides protection for the ES apparatus during shipment and storage. It also provides for storage of the footswitches. The polyurethane material has cutouts to position the ES apparatus and footswitches.

d. Canvas case (fig 1-6). The olive drab canvas case with hook-and-loop fasteners provides protection for the mobile cart during shipment and storage. The canvas case also confines the ES apparatus accessories stored on the mobile cart shelves.

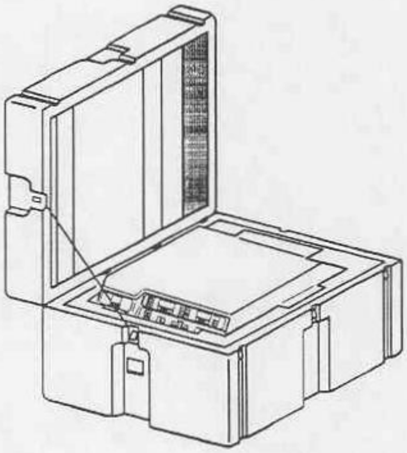


Figure 1-5. Shipping/storing chest.

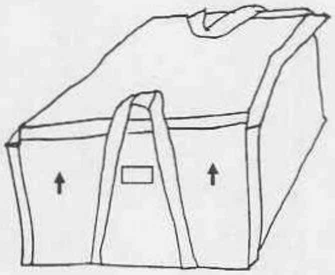


Figure 1-6. Canvas case.

e. Handswitching forceps (fig 1-7). The reusable, stainless steel, handswitching forceps are used for bipolar modes of operation. The forcep tines incorporate the electrical switch. The forceps have serrated sections for gripping and are also provided with blue, plastic tip protectors and cylindrical, clear-plastic storage tubes.

f. Handswitching forceps cable assembly (fig 1-8). The cable assembly consists of a three-conductor electrical cable, a forceps-compatible female connector, and a molded connector configured to fit only the "MICROBIPOLAR" receptable. The cable assembly can be sterilized and reused.

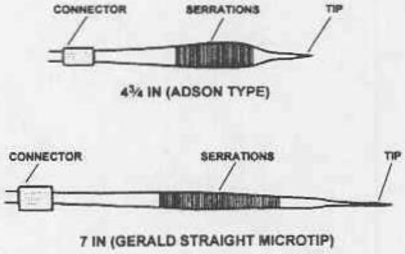

CONNECTOR
SERRATIONS
TIP
4¾ IN (ADSON TYPE)
CONNECTOR
SERRATIONS
TIP
7 IN (GERALD STRAIGHT MICROTIP)

Figure 1-7. Handswitching forceps.

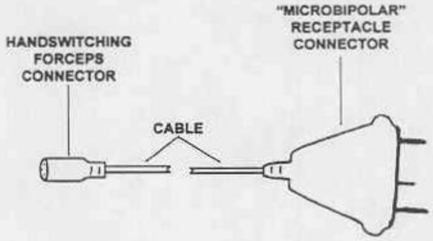

"MICROBIPOLAR" RECEPTACLE CONNECTOR
HANDSWITCHING FORCEPS CONNECTOR
CABLE

Figure 1-8. Handswitching forceps cable assembly.

g. Handswitching pencil(s) (fig 1-9). A handswitching pencil consists of a single piece body with an attached three-conductor cable and receptacle connector. The pencil body incorporates a rocker switch for selecting CUT or COAG modes of operation. A flat blade electrode is initially furnished with the pencil. One pencil can be sterilized and reused and the other pencil is disposable.

WARNING

Accessories identified as disposable are to be used only once. Do not sterilize or reuse.

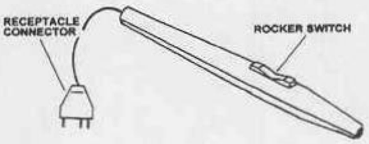

RECEPTACLE CONNECTOR
ROCKER SWITCH

Figure 1-9. Handswitching pencil.

h. Surgical handle (fig 1-10). The surgical handle consists of a two-piece serrated body which screws together to serve as the locking mechanism to firmly hold a variety of electrodes. The handle includes a single conductor electrical cable and receptacle connector. The surgical handle can be sterilized and reused.

i. Patient return electrode cable assembly (fig 1-11). This cable assembly consists of a two-conductor electrical cable, a front panel "PATIENT" receptacle connector, and two single conductor electrical connectors which thread onto the patient return electrode threaded lugs. The cable assembly can be sterilized and reused.

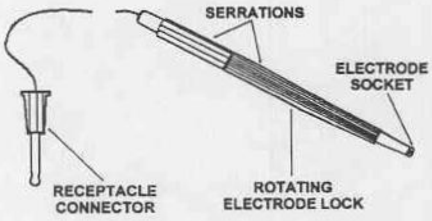

SERRATIONS
ELECTRODE SOCKET
RECEPTACLE CONNECTOR
ROTATING ELECTRODE LOCK

Figure 1-10. Surgical handle.

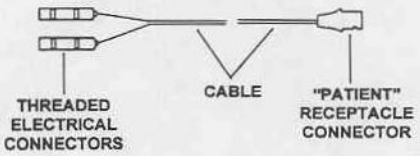

THREADED ELECTRICAL CONNECTORS
CABLE
"PATIENT" RECEPTACLE CONNECTOR

Figure 1-11. Patient return electrode cable assembly.

j. Reusable patient return electrode (fig 1-12). The patient return electrode consists of a flat, stainless steel plate with two threaded studs mounted on one end which connect to the patient return electrode cable assembly. The patient return electrode does not require sterilization.

k. Disposable patient return electrode (fig 1-13). The disposable patient return electrode consists of a pad of conductive gel, an adhesive border, a two-conductor electrical cable, and the ES apparatus front panel "PATIENT" receptacle connector.

WARNING

Do not sterilize and reuse this electrode.

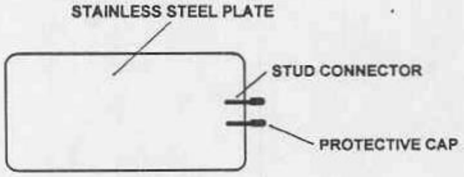

STAINLESS STEEL PLATE
STUD CONNECTOR
PROTECTIVE CAP

Figure 1-12. Reusable patient return electrode.

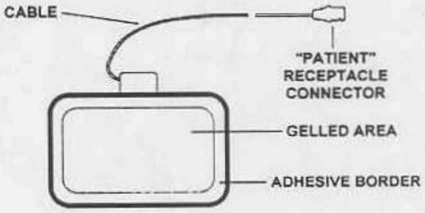

CABLE
"PATIENT" RECEPTACLE CONNECTOR
GELLED AREA
ADHESIVE BORDER

Figure 1-13. Disposable patient return electrode.

l. Surgical electrodes (fig 1-14). Five reusable electrodes are provided with the ES apparatus for application as required in support of combat casualty care.

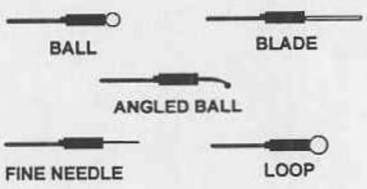

BALL
BLADE
ANGLED BALL
FINE NEEDLE
LOOP

Figure 1-14. Surgical electrodes.

1-13. Tabulated data, decals, and data plates.

The tabulated data provides the specifications, physical characteristics, and other information for the ES apparatus.

a. Specifications and physical characteristics. Tables 1-2 and 1-3 provide a broad range of specifications and physical characteristics to include output waveforms, low voltage electrical leakage values, output characteristics, operating voltages, and environmental ranges.

Table 1-2. Specifications.

Output Waveforms	
Pure Cut Mode	500 kHz sinusoid
Blend 1	500 kHz bursts of sinusoid at 50% duty cycle recurring at 31 kHz
Blend 2	500 kHz bursts of sinusoid at 37.5% duty cycle recurring at 31 kHz
Blend 3	500 kHz bursts of sinusoid at 25% duty cycle recurring at 31 kHz
Coag	500 kHz damped sinusoidal bursts with a repetition frequency of 31 kHz
Low Voltage Coag	500 kHz bursts of sinusoid at 25% duty cycle recurring at 31 kHz
Bipolar	500 kHz unmodulated sinusoid
Low Frequency (50/60 Hz) Electrical Leakage Currents (source current, patient lead, all outputs tied together)	
Normal polarity, intact chassis ground	< 10 μA
Normal polarity, ground open	< 100 μA
Reverse polarity, ground open	< 100 μA
Sink current, 140 V applied, all inputs	< 150 μA
Chassis source current, ground open	< 100 μA
Radio Frequency (RF) Electrical Leakage Currents	
Bipolar	< 150 μA
Monopolar	< 150 μA

Output Characteristics

Mode	Maximum open circuit (P-P voltage)	Rated load (Ohms)	Nominal Power at rated load (Watts)*	Crest Factor at rated load (Watts, ±20%)
Cut	3000	300	300	1.9 @ 100 W
Blend 1	3500	300	250	3.3 @ 100 W
Blend 2	3700	300	200	4.0 @ 100 W
Blend 3	4000	300	150	4.8 @ 100 W
Coag	7000	300	120	9.0 @ 50 W
Low Voltage Coag	4000	300	99	4.8 @ 100 W
Bipolar	800	100	70	2.0 @ 40 W

*Power readouts agree with actual power into rated load to within 15% or 5 watts, whichever is greater.

Table 1-3. Physical characteristics.

Operating voltages	95 VAC to 140 VAC, 50/60 Hz or 190 VAC to 270 VAC, 50/60 Hz
Temperature ranges	
Operating	10°C (50°F) to 40°C (104°F)
Storing	-40°C (-40°F) to 70°C (158°F)

Table 1-3. Physical characteristics - continued.

Humidity ranges	
Operating	30% to 75%
Storing	10% to 100%
Atmospheric pressures	
Operating	500 mbar to 1060 mbar
Storing	500 mbar to 2500 mbar
Alarm and mode indicator tones	45 dBa to 65 dBa at 1 m (3.28 ft) maximum
Electrical power cord length	4.575 m (15 ft)
Electrical power connector	115 VAC (nominal), 3-conductor, hospital grade
ES apparatus dimensions	
Width	33 cm (13 in)
Length	53 cm (21 in)
Height	20 cm (8 in)
Shipping/storing chest dimensions	
Width	73.7 cm (29 in)
Length	50.8 cm (20 in)
Height	43.2 cm (17 in)
Mobile cart dimensions	
Width	40.6 cm (16 in)
Length	68.6 cm (27 in)
Height	76.2 cm (30 in)
Weight	
ES apparatus	16.12 kg (35.5 lbs)
Shipping/storing chest with accessories	14.53 kg (32.0 lbs)
Canvas case with mobile cart	29.74 kg (65.5 lbs)
Electrode shaft size	2.4 mm (3/32 in)
Acceptable patient return electrode circuit resistance	< 20 ohms
Amperage ranges (maximum), 115 V/230 V	
Standby mode	0.4 A/0.2 A
Cut mode	9.0 A/6.0 A
Coag mode	4.0 A/1.5 A
Bipolar mode	3.0 A/0.75 A

b. Identification, instruction, and warning plates, decals, or markings.

(1) The chest manufacturer data plate, located on the front of the chest is depicted in figure 1-15. The data includes the ES apparatus national stock number (NSN) and nomenclature.

CASE, MEDICAL, TRANSIT AND STORAGE - 1 OF 2
ITEM: ELECTROSURGICAL APPARATUS
NSN: 6515-01-309-6647
MANUFACTURER'S PART NUMBER AP7705
MANUFACTURER'S NAME: ADVANCED PACKAGING, INC.
Baltimore, Maryland

Figure 1-15. Chest manufacturer data plate.

(2) Two decals (located under the handle on each side of the chest) providing handling instructions and information about the chest are depicted in figure 1-16.

DELICATE UNIT

HANDLE WITH
CARE
REUSABLE CONTAINER

Figure 1-16. Chest decals.

(3) "DANGER," "WARNING," and "CAUTION" statements provided in the English and French languages, are stenciled on the top of the ES apparatus case. The English language version is depicted in figure 1-17.

(4) A decal (located on the top of the ES apparatus case) providing information about the simultaneous use of two active electrodes in COAG mode is depicted in figure 1-18.

DANGER
EXPLOSION HAZARD. DO NOT USE IN THE PRESENCE OF FLAMMABLE ANAESTHETICS.

WARNING
HAZARDOUS ELECTRICAL OUTPUT. THIS EQUIPMENT IS FOR USE ONLY BY QUALIFIED PERSONNEL.

WARNING
USE OF A CONVENTIONAL, PATIENT RETURN ELECTRODE WILL NOT ACTIVATE THE CONTACT QUALITY MONITORING SYSTEM.

CAUTION
THIS EQUIPMENT HAS AN OUTPUT WHICH IS CAPABLE OF CAUSING A PHYSIOLOGICAL EFFECT.

CAUTION
ELECTRICAL SHOCK HAZARD. DO NOT REMOVE COVER. REFER TO AUTHORIZED PERSONNEL FOR SERVICE.

Figure 1-17. Stenciled statements.

The Force 2 is designed for use with the Valleylab Power Control Pencil.

The Force 2 will permit simultaneous, independent use of two active electrodes in the Coag Mode when fulgurating from the MONOPOLAR (HAND-SWITCH and ACCESSORY) receptacles. The generator will not permit the use of more than one output in any other modes.

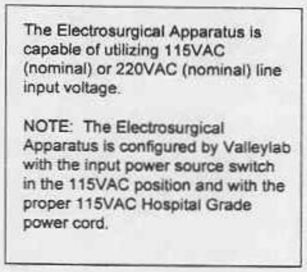
Refer to the generator instruction Manual.

Figure 1-18. Electrode use decal.

NOTE

Additional information on the decal about contacting the manufacturer for assistance is not duplicated. The first source of assistance is through the Army maintenance system.

(5) A decal (located on the top of the ES apparatus case) providing information about voltage conversion of the ES apparatus and the position of the conversion switch is depicted in figure 1-19.

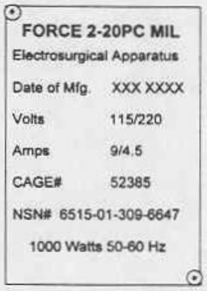


The Electrosurgical Apparatus is capable of utilizing 115VAC (nominal) or 220VAC (nominal) line input voltage.

NOTE: The Electrosurgical Apparatus is configured by Valleylab with the input power source switch in the 115VAC position and with the proper 115VAC Hospital Grade power cord.

Figure 1-19. Voltage conversion decal.

(6) The manufacturer data plate (located on the back of the ES apparatus) is depicted in figure 1-20.



FORCE 2-20PC MIL
Electrosurgical Apparatus

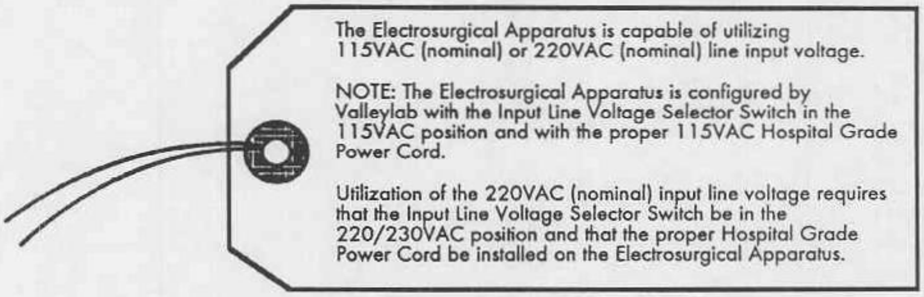
Date of Mfg.	XXX XXXX
Volts	115/220
Amps	9/4.5
CAGE#	52385

NSN# 6515-01-309-6647

1000 Watts 50-60 Hz

Figure 1-20. ES apparatus manufacturer data plate.

(7) A cardboard tag (tied to the electrical power cord) provides information about the use of multiple voltages (fig 1-21).



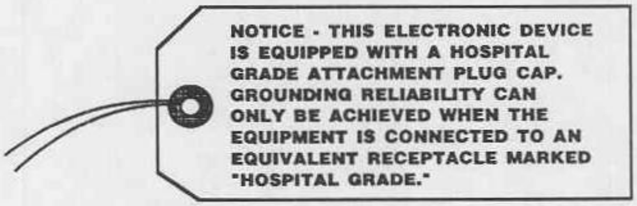
The Electrosurgical Apparatus is capable of utilizing 115VAC (nominal) or 220VAC (nominal) line input voltage.

NOTE: The Electrosurgical Apparatus is configured by Valleylab with the Input Line Voltage Selector Switch in the 115VAC position and with the proper 115VAC Hospital Grade Power Cord.

Utilization of the 220VAC (nominal) input line voltage requires that the Input Line Voltage Selector Switch be in the 220/230VAC position and that the proper Hospital Grade Power Cord be installed on the Electrosurgical Apparatus.

Figure 1-21. Voltage tag.

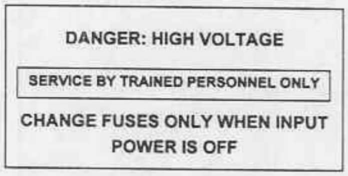
(8) A cardboard tag (tied to the electrical power cord) provides information about the hospital grade electrical connector (fig 1-22).



NOTICE - THIS ELECTRONIC DEVICE IS EQUIPPED WITH A HOSPITAL GRADE ATTACHMENT PLUG CAP. GROUNDING RELIABILITY CAN ONLY BE ACHIEVED WHEN THE EQUIPMENT IS CONNECTED TO AN EQUIVALENT RECEPTACLE MARKED "HOSPITAL GRADE."

Figure 1-22. Electrical connector tag.

(9) A decal (located on the plastic electronics cover inside the ES apparatus) providing safety information is depicted in figure 1-23.



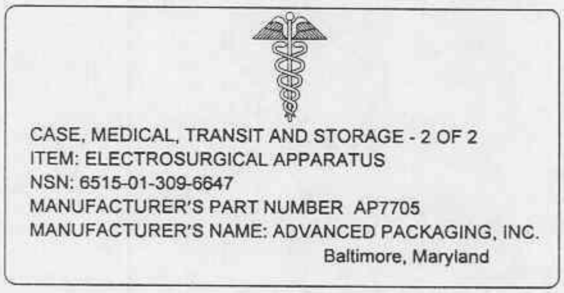
DANGER: HIGH VOLTAGE

SERVICE BY TRAINED PERSONNEL ONLY

CHANGE FUSES ONLY WHEN INPUT
POWER IS OFF

Figure 1-23. High voltage danger decal.

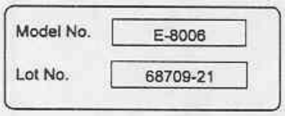
(10) The canvas case manufacturer identification card (located in a plastic holder on the front of the case) is depicted in figure 1-24.



CASE, MEDICAL, TRANSIT AND STORAGE - 2 OF 2
ITEM: ELECTROSURGICAL APPARATUS
NSN: 6515-01-309-6647
MANUFACTURER'S PART NUMBER AP7705
MANUFACTURER'S NAME: ADVANCED PACKAGING, INC.
Baltimore, Maryland

Figure 1-24. Case manufacturer identification card.

(11) The mobile cart manufacturer data plate (located on the side of the cart) is depicted in figure 1-25.



Model No. E-8006

Lot No. 68709-21

Figure 1-25. Mobile cart manufacturer data plate.

1-14. Model differences.

Model differences are not applicable since this manual covers a single model.

1-15. Safety, care, and handling.

a. Observe each WARNING, CAUTION, and NOTE in this manual.

NOTE

The manufacturer uses the term DANGER to provide safety information that equates to the WARNING term used in U.S. Army manuals.

b. The safe and effective use of the ES apparatus is dependent, to a large degree, upon factors under the control of operator personnel. There is no substitute for highly trained and vigilant operator personnel. It is very important that the operating and safety instructions be read, understood, and followed.

c. Electrosurgery is employed in many surgical procedures. Nevertheless, extra precautions may be necessary because of the presence of external or internal pacemakers and monitoring equipment, or the patient's condition. Prior to starting the procedure, the ES apparatus operator/user must be familiar with medical literature on the use, complications, and hazards of electrosurgery involving the surgical procedure.

WARNING

Electrosurgery uses radio frequency to cut and/or coagulate tissue. The sparking and heat can provide an ignition source. Accordingly, the ES apparatus is inherently unsafe for use with flammable anesthetics or other flammable gases, near flammable fluids or objects, or with oxidizing agents.

d. General precautions are as follows:

(1) Prevent the accumulation of oxygen, other oxidizing gases such as nitrous oxide, and flammable gases under surgical drapes or within the area where the ES apparatus is being used.

(2) Verify that all oxygen connections on nearby equipment are leak-free before and during electrosurgical procedures.

(3) Do not use electrosurgery in the presence of naturally occurring flammable gases which may accumulate in a patient's body cavities such as the bowel.

(4) Do not use electrosurgical procedures in the presence of flammable liquids such as skin prepping agents and tinctures.

(5) Do not place electrosurgical active accessories near or in contact with flammable materials such as gauze. Electrosurgical accessories which are hot from use or accessories which are activated can cause a fire.

(6) Use the ES apparatus with caution in the presence of internal or external pacemakers. Interference from the electrosurgical current may cause a pacemaker to enter an asynchronous mode or the interference may cause other problems.

(7) Prevent the patient from direct contact with grounded metal objects such as a surgical table frame, instrument table, etc. If this is not possible during specific procedures, use extreme caution to maintain patient safety.

(8) Place the electrodes and/or probes as far as possible from the surgical site and the patient return electrode to reduce the risk of an electrosurgical burn. Electrodes and probes used on monitoring, stimulation, and imaging devices can provide a path for high frequency current from an ES apparatus, even if the electrodes and/or probes are isolated at 60 Hz, insulated, and/or battery operated. Protective impedances (resistors or radio frequency inductors) installed in the monitoring leads may reduce the risk of such burns. Additionally, needles should not be used as monitoring electrodes during electrosurgical procedures.

(9) Provide as much distance as possible between the ES apparatus and other electronic equipment to minimize interference paths between conducted and radiated electrical fields and other electronic medical equipment.

(10) Prevent skin-to-skin contact such as between the arms and trunk of a patient by placing two or three inches of dry gauze between such body areas. This will reduce the potential for multiple burns caused by the ES apparatus.

Section III. PRINCIPLES OF OPERATION

1-16. Basic operation.

a. The basic operation of the ES apparatus involves converting low frequency electrical power to high frequency electrical power for electrosurgical procedures. Like any other application of electricity, a complete circuit is required for current flow. The two circuits available correspond to the operating modes as follows:

(1) *Bipolar mode.* This circuit starts at the solid-state, high-frequency oscillator of the ES apparatus. The current passes through an active cable, an electrode, a small volume of tissue, through another electrode and cable, and back to the high-frequency oscillator.

NOTE

The two electrodes in the bipolar mode are generally the two tips of the forceps. Bipolar electrosurgery is primarily used to coagulate fine tissue in neurosurgery, gynecologic, and ophthalmologic procedures.

(2) *Monopolar mode*. This circuit also starts at the solid-state, high-frequency oscillator in the ES apparatus. The current passes through an active cable, an electrode, a small volume of tissue, through another electrode and cable, and back to the high-frequency oscillator. The return electrode is typically placed at a site on the patient remote from the surgical site and its associated cable.

NOTE

The patient return electrode must have a relatively large area of contact with the patient to disperse the current and to provide a low resistance exit path and low current density from the patient as illustrated in figure 1-26.

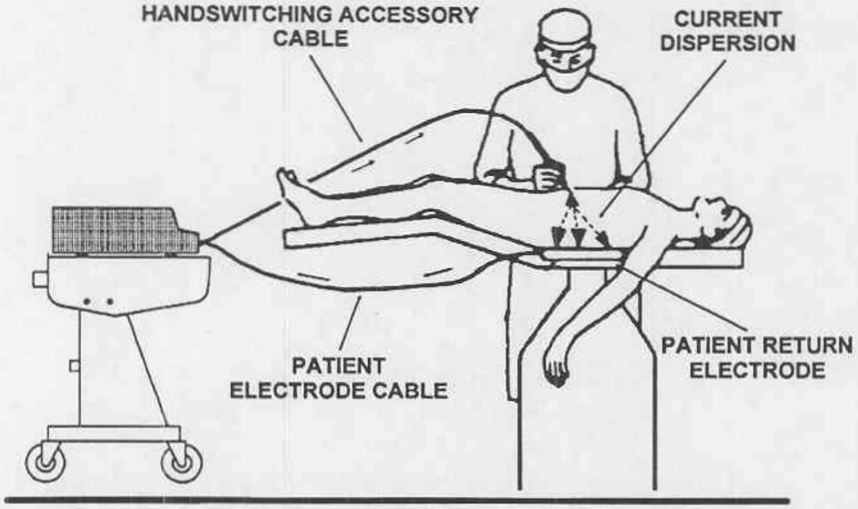


Figure 1-26. Monopolar patient circuit.

b. The electrosurgical heating effect that causes tissue destruction is not produced by a heated electrode or tip, but by a high-frequency current concentrated with high current density in tissue directly under the electrode point of contact. Coagulation occurs when the temperature of the tissue of cells in contact with or near the active electrode is raised to a point at which the protein in the cells becomes denatured. The waveform, power, tissue type, and electrode size/shape are some of the factors that determine the surgical effect.

DRAFT

CHAPTER 2

OPERATING INFORMATION AND INSTRUCTIONS

Section I. GENERAL

2-1. Scope.

This manual is primarily intended to provide information, instructions, and procedures for the maintenance of the ES apparatus. The operating information and instructions, while valid, do not provide sufficient information for use of the ES apparatus on a patient. Only qualified medical clinicians are trained in specific surgical techniques and procedures.

2-2. Initial start-up procedures.

Initial start-up procedures are as follows:

a. Unpack, assemble, and prepare the ES apparatus for operation by following the procedures in chapter 3, section II.

b. Determine a source and characteristics of available voltage.

c. Ensure that the red, recessed slide switch (located on the back of the ES apparatus) for electrical power conversion is in the voltage position ("115 V" or "220 V") matching the available voltage.

d. Ensure that the electrical power toggle switch is at the "O" (off) symbol.

e. Plug the ES apparatus power cord connector into a grounded electrical wall receptacle.

WARNING

Do not connect the ES apparatus into an ungrounded electrical receptacle. Do not use an extension cord. Do not use a three-conductor to two-conductor adapter.

Undesirable 50- to 60-hertz electrical leakage currents may be caused by the incorrect polarity of the electrical power cord connectors or the electrical power receptacles. Ensure that the polarity is correct.

NOTE

The ES apparatus is initially supplied with a hospital-grade, 115-volt electrical connector. The use of 230-volt electrical power will require the installation of an appropriate grounded, electrical connector.

f. Pull the electrical power toggle switch (located on the back panel of the ES apparatus) up to the "|" (on) symbol.

Section II. PREPARATION FOR OPERATION

2-3. Controls, indicators, displays, and receptacles.

a. The function and location of front panel controls, indicators, displays, and receptacles are as follows:

(1) *Microbipolar (MBP) section (fig 2-1).*

(a) *Digital display.* The red digital display shows the power setting, in watts, that will be delivered to the patient when this mode is activated.

(b) *"WATTS" indicator.* The blue watts indicator illuminates when "MBP POWER" output is activated.

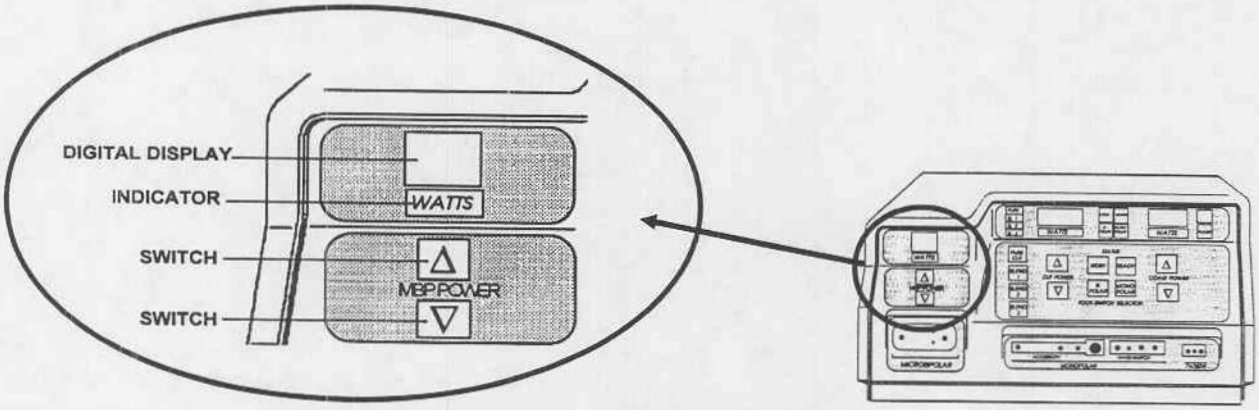

DIGITAL DISPLAY
INDICATOR
WATTS
SWITCH
MBP POWER
SWITCH

Figure 2-1. Front panel, MICROBIPOLAR section.

NOTE

A distinctive mode indicator tone will sound when the visual "WATTS" indicator illuminates.

(c) *Power output switches.* The blue up (Δ) and down (∇) "MBP POWER" keyboard switches increase or decrease the power output (watts) setting shown in the digital display. The available power ranges from 1 to 70 watts. A single depression of either switch increases or decreases the digital display setting by 1 watt. Continuous depression of either switch gradually increases or decreases the digital display setting to the maximum or minimum.

(2) *CUT section (fig 2-2).*

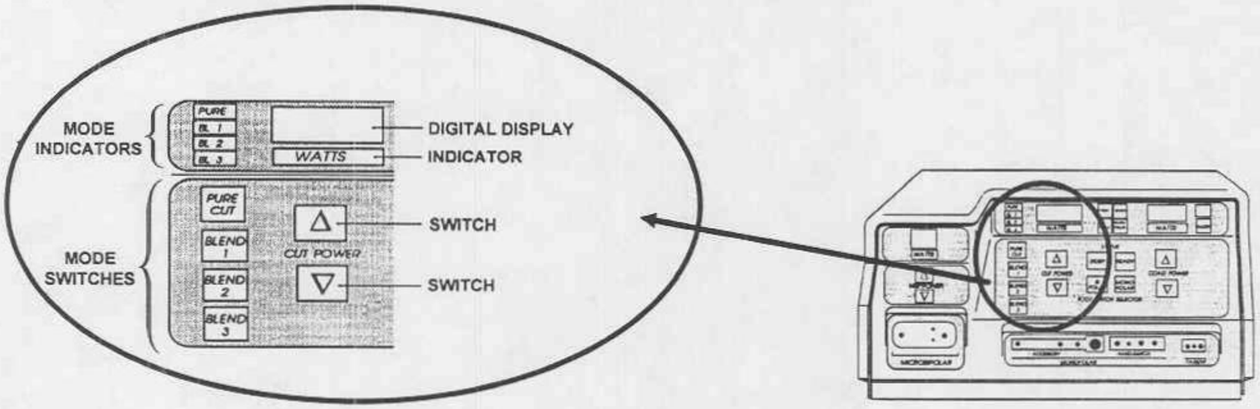

MODE INDICATORS
PURE
BL 1
BL 2
BL 3
DIGITAL DISPLAY
WATTS
INDICATOR
PURE CUT
BLEND 1
BLEND 2
BLEND 3
CUT POWER
SWITCH
SWITCH
MODE SWITCHES

Figure 2-2. Front panel, CUT section.

(a) *Cut mode indicators.* The yellow cut mode indicators, identified as "PURE," "BL 1," "BL 2," and "BL 3," illuminate when the corresponding cut mode switches are depressed.

(b) *Cut mode switches*. The yellow "PURE CUT," "BLEND 1," "BLEND 2," and "BLEND 3" keyboard switches are depressed to select the desired cut mode. The "PURE CUT" switch selects electrosurgery cutting with the lowest level of hemostasis. Likewise, the "BLEND 1," "BLEND 2," and "BLEND 3" switches select electrosurgery cutting with minimum, average, and maximum hemostasis.

(c) *Digital display.* The red digital display shows the power setting, in watts, that will be delivered to the patient when this mode is activated.

(d) *"WATTS" indicator.* The yellow watts indicator illuminates when "CUT POWER" is activated.

(e) *Power output switches*. The yellow up (Δ) and down (∇) "CUT POWER" keyboard switches increase or decrease the power output (watts) setting shown in the digital display. The available power ranges from 1 to 300 watts. A single depression of either switch increases or decreases the digital display setting by 1 watt. Continuous depression of either switch gradually increases or decreases the digital display setting to the maximum or minimum.

(3) *"STATUS" and "FOOT-SWITCH SELECTOR" section (fig 2-3).*

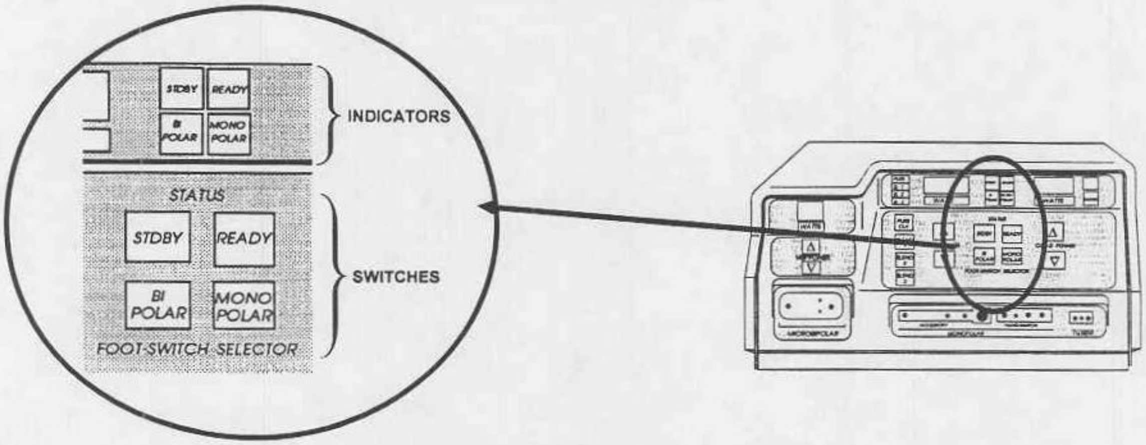


Figure 2-3. Front panel, STATUS section.

(a) *Indicators*. The status and footswitch selector indicators, identified as "STDBY," "READY," "BIPOLAR," and "MONOPOLAR," illuminate when the corresponding "STATUS" and "FOOT-SWITCH SELECTOR" switches are depressed. The "STDBY," "BIPOLAR," and "MONOPOLAR" indicators are yellow and the "READY" indicator is green.

(b) *"STDBY" (standby) switch.* This white keyboard switch is depressed to put the ES apparatus into a standby mode. In this mode the ES apparatus output cannot be activated, the audio alarms are silenced, the displays show "- - -," and the previous settings are held in memory. The ES apparatus defaults to the standby mode when the back panel electrical power toggle switch is pushed to the "O" symbol then back to the "|" symbol.

(c) *"READY" switch.* This white keyboard switch is depressed to make the ES apparatus fully operational.

(d) *"BIPOLAR" switch.* This white keyboard switch is depressed to select the bipolar output when using the monopolar footswitch.

(e) *"MONOPOLAR" switch*. This white keyboard switch is depressed to select monopolar footswitch control for activating accessory output.

(4) *COAG (coagulation) section (fig 2-4).*

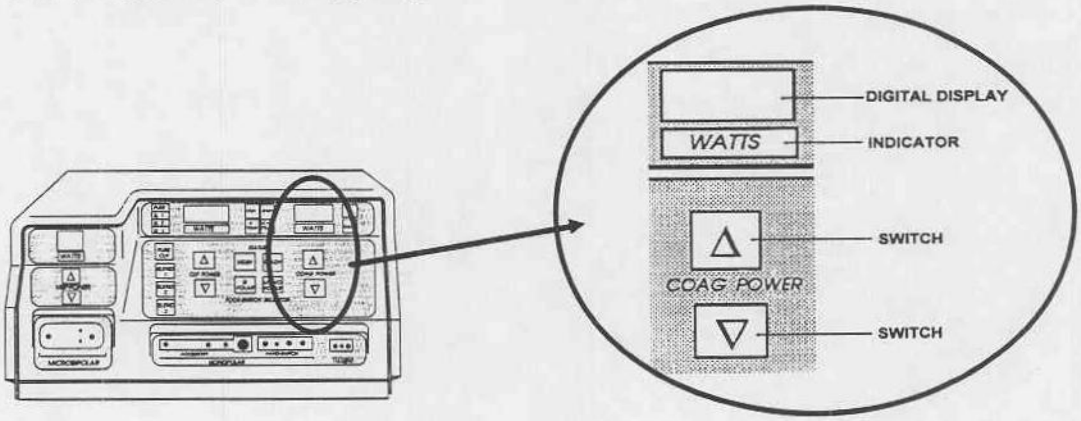


Figure 2-4. Front panel, COAG section.

(a) *Digital display.* The red digital display shows the power setting, in watts, that will be delivered to the patient when this mode is activated.

(b) *"WATTS" indicator.* The blue watts indicator illuminates when "COAG POWER" is activated.

(c) *Power output switches*. The blue up (Δ) and down (∇) "COAG POWER" keyboard switches increase or decrease the power output (watts) setting shown in the digital display. The available power ranges from 1 to 120 watts. A single depression of either switch increases or decreases the digital display setting by 1 watt. Continuous depression of either switch gradually increases or decreases the digital display setting to the maximum or minimum.

(5) *Other indicators (fig 2-5).*

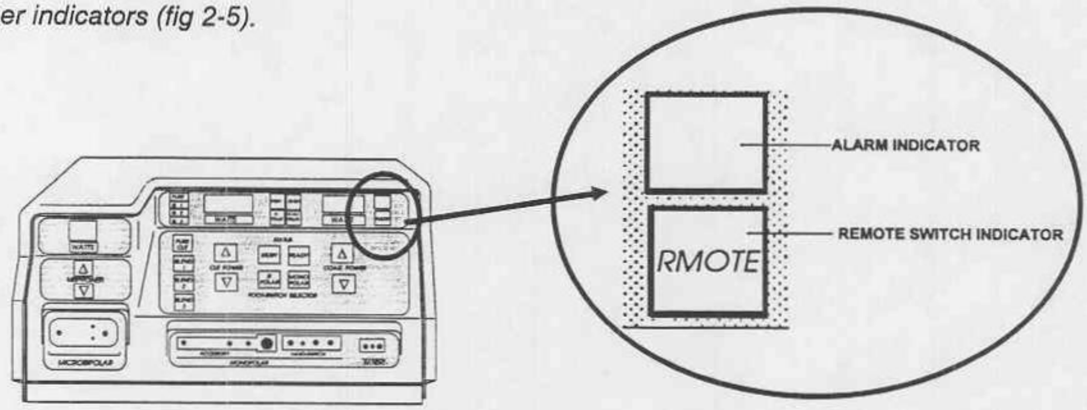


Figure 2-5. Front panel, other indicators.

(a) *Alarm indicator.* This red alarm indicator illuminates when the pin to pin resistance at the patient electrode connector exceeds 20 ohms. An alarm tone will also sound twice and further electrosurgery will be prevented until the resistance is less than 20 ohms.

NOTE

The fault detection system is capable of detecting broken wires or broken patient return electrode circuit connectors.

The ES apparatus quality monitoring system is not activated because the unique patient return electrode is not provided.

(b) *"RMOTE" (remote) indicator.* This green indicator illuminates when the remote power change feature is activated when using a power control handswitching pencil (not provided). A single audio tone will also sound when use of the remote control is detected.

NOTE

Depress either the white keyboard switch to return the ES apparatus to the standby mode or push the electrical power toggle switch to the "O" symbol until further use is required.

(6) *Receptacles section (fig 2-6).*

(a) *"MICROBIPOLAR" receptacle.* This receptacle is designed for use with 3-pin bipolar handswitch or footswitch activated accessories. The receptacle can also be used with 2-pin bipolar footswitch activated accessories.

(b) *"MONOPOLAR" "ACCESSORY" receptacle.* This receptacle is designed for use with 3-pin handswitching active accessories or standard 1-pin accessories which can be activated by the monopolar footswitch. CUT and COAG modes may be activated at this receptacle. The handswitching pencil can be footswitch activated when connected to this output receptacle.

WARNING

Do not connect more than one accessory to this receptacle as both the 3-pin and 1-pin output receptacles will activate simultaneously.

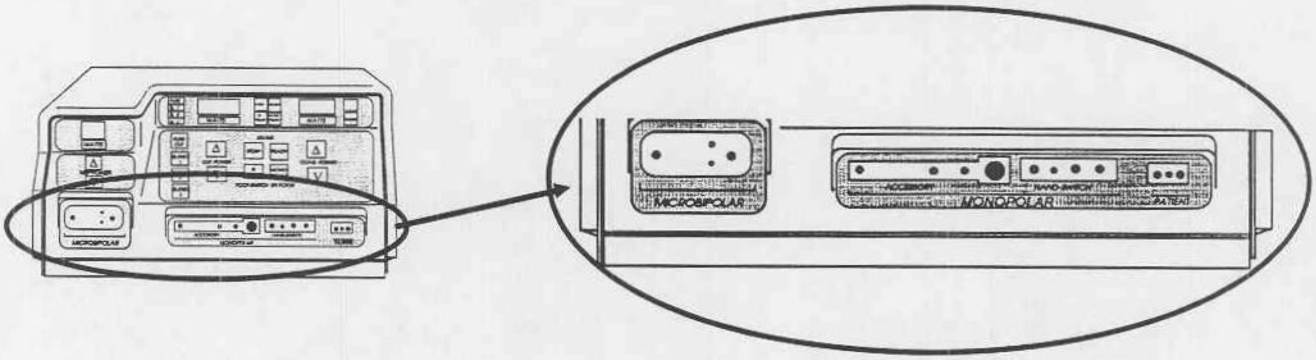

MICROBIPOLAR
ACCESSORY
HAND-SWITCH
MONOPOLAR
PATIENT

Figure 2-6. Front panel receptacles.

(c) *"MONOPOLAR" "HAND-SWITCH" receptacle.* This receptacle is designed for use with 3-pin handswitching active accessories only. Both CUT and COAG modes may be activated at this receptacle.

NOTE

No power is available through this receptacle by use of the footswitch.

The handswitching pencil is only functional through this receptacle.

(d) *"PATIENT" return electrode receptacle.* This 3-pin receptacle is designed to accept the patient return electrode connector (2-pin) used in monopolar procedures. The receptacle will also accept dual-section (3-pin) and conventional patient return electrode connectors (2-pin).

b. The function and location (fig 2-7) of back panel controls, receptacles, and other components are as follows:

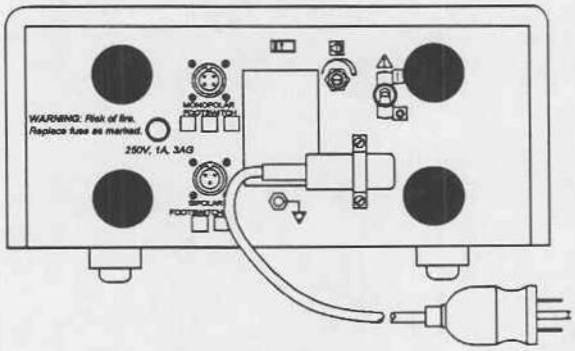

MONOPOLAR FOOTSWITCH
WARNING: Risk of fire. Replace fuse as marked.
250V, 1A, 3AG
BIPOLAR FOOTSWITCH

Figure 2-7. Apparatus back panel.

(1) *Rubber feet.* The four rubber feet are used for protection of back panel components when used as a portable apparatus.

(2) *Fuse.* The 1-amp, 250-volt fuse provides electrical power protection from both internal and external problems.

(3) *"MONOPOLAR FOOTSWITCH" receptacle.* This 4-pin receptacle is for the connection of a dual-pedal monopolar footswitch.

(4) *"BIPOLAR FOOTSWITCH" receptacle.* This 3-pin receptacle is for the connection of a single-pedal bipolar footswitch.

(5) *Volume control.* The slotted potentiometer is for varying the volume of the MBP, CUT, and COAG mode indicator tones produced when a mode is activated.

NOTE

The volume of the alarm tone for the patient return electrode alarm is not adjustable.

(6) *Voltage selector slide switch.* The red slide switch is used to select either "115 V" or "220 V" operation. The selected voltage is displayed.

(7) *Electrical power toggle switch.* The on ("|") or off ("O") switch controls electrical power to the ES apparatus. The switch also incorporates a circuit breaker for electrical protection.

(8) *Power cord assembly.* The grounded, 3-conductor electrical power cord connector is fastened to the rear panel with a metal retaining strap and two slotted screws.

(9) *Grounding terminal.* The grounding terminal is used to provide an external electrical ground.

Section III. COMPONENTS, ACCESSORIES, AND ELECTRODES

2-4. General.

a. This section provides installation instructions, general information, and illustrations of accessory and electrode connections.

b. Accessories labeled as "disposable" are to be used only one time. Do not reuse them even if they have been sterilized.

WARNING

Potentially hazardous conditions may exist if ES apparatus accessories are used in the incorrect receptacles.

NOTE

Use only sterile accessories and electrodes on a patient.

2-5. Footswitches.

a. Installation (fig 2-8).

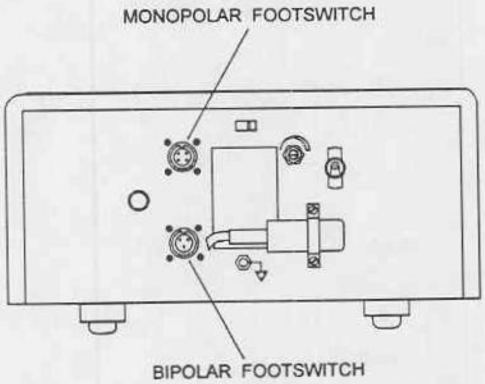


Figure 2-8. Footswitch connections.

(1) *Monopolar footswitch.*

(a) Ensure that the ES apparatus is not energized or is in "STDBY" mode by observing that the yellow "STDBY" indicator is illuminated. If not, depress the white "STDBY" keyboard switch.

(b) Attach the male, 4-pin connector on the monopolar footswitch to its mating female receptacle on the back panel of the ES apparatus by aligning the keyways, pushing the connector collar inward, and then turning the knurled sleeve clockwise until tight.

(2) *Bipolar footswitch.*

(a) Ensure that the ES apparatus is not energized or is in "STDBY" mode by observing that the yellow "STDBY" indicator is illuminated. If not, depress the white "STDBY" keyboard switch.

(b) Attach the male, 3-pin connector on the bipolar footswitch to its mating female receptacle on the back panel of the ES apparatus by aligning the keyways, pushing the connector collar inward, and then turning the knurled sleeve clockwise until tight.

b. Operation. The footswitches are operated by depressing a pedal with your foot.

2-6. Handswitching forceps and pencils.

a. Installation.

(1) *Handswitching forceps (fig 2-9).*

(a) Ensure that the ES apparatus is not energized or is in "STDBY" mode by observing that the yellow "STDBY" indicator is illuminated. If not, depress the white "STDBY" keyboard switch.

(b) Attach the bipolar forceps cable assembly to either the 4 ¾-inch or the 7-inch forceps by aligning the slot on the cable receptacle with the slot on the forceps connector and pushing them together firmly.

(c) Plug the forceps cable connector into the "MICRO-BIPOLAR" receptacle located on the lower left side of the ES apparatus front panel.

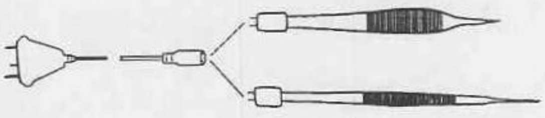


Figure 2-9. Handswitching forceps connections.

(2) *Handswitching pencils (fig 2-10).*

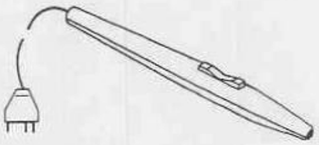


Figure 2-10. Handswitching pencil.

NOTE

Using a handswitching pencil with various electrodes requires using a patient return electrode. Refer to paragraph 2-7 for additional information and instructions.

Handswitching pencils are both reusable and disposable types. Discard disposable pencils after a single use. Do not resterilize and use again.

(a) Ensure that the ES apparatus is not activated or is in "STDBY" mode by observing that the yellow "STDBY" indicator is illuminated. If not, depress the white "STDBY" keyboard switch.

(b) Insert the required electrode into the handswitching pencil by grasping the electrode by the insulating sleeve and inserting its round shank into the pencil until the insulating sleeve is inserted completely. The electrode will fit securely in the pencil.

WARNING

Incorrect electrode installation may result in injury to the patient or operating room personnel by arcing at the electrode and pencil connection.

NOTE

The electrode orientation may be changed by pulling out the electrode, rotating it, and then reinserting it into the pencil.

(c) Insert the male connector into the "MONOPOLAR" "HAND-SWITCH" receptacle. Seat it firmly.

b. Operation. Refer to this chapter, section IV, for operating instructions.

2-7. Patient return electrodes.

NOTE

A patient return electrode is always required when using monopolar electrodes. Since the patient return electrode is not grounded at low frequencies, this manual will refer to it as an electrode and not as a "ground plate." This terminology should help in preventing the use of the patient return electrode as a convenient electrical grounding point.

a. Installation.

(1) *Patient return electrode (reusable) (fig 2-11).*

(a) Ensure that the ES apparatus is not activated or is in "STDBY" mode by observing that the yellow "STDBY" indicator is illuminated. If not, depress the white "STDBY" keyboard switch.

(b) Connect the patient return electrode to the patient return cable assembly by screwing the cable connectors onto the threaded studs. Ensure that the threaded connections are tight. Then connect the female patient connector into the "MONOPOLAR" "PATIENT" receptacle. Seat it firmly.

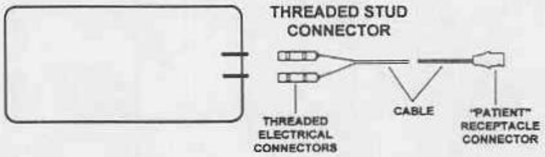

THREADED STUD CONNECTOR
THREADED ELECTRICAL CONNECTORS
CABLE
"PATIENT" RECEPTACLE CONNECTOR

Figure 2-11. Patient return electrode (reusable).

NOTE

Retain the plastic protective caps from the threaded studs to protect them when the patient return electrode is not in use.

Apply conductive gel to the patient return electrode before patient use.

(2) *Patient return electrode (disposable) (fig 2-12).*

(a) Ensure that the ES apparatus is not energized or is in "STDBY" mode by observing that the yellow "STDBY" indicator is illuminated. If not, depress the white "STDBY" keyboard switch.

(b) Apply a disposable patient return electrode by following the manufacturer's procedures.

(c) Connect the female connector into the "MONOPOLAR" "PATIENT" receptacle. Seat it firmly.

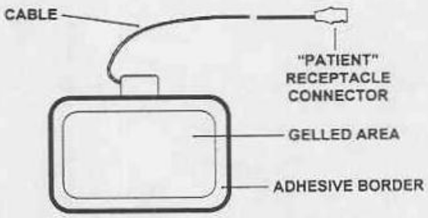


Figure 2-12. Patient return electrode (disposable).

NOTE

Electrode gel is not required for the disposable electrode and should not be used.

WARNING

Disposable patient return electrodes are to be used only one time. Do not sterilize or reuse.

b. Operation. Refer to paragraph 2-14 for patient return electrode application instructions.

2-8. Surgical handle (with cable assembly) (fig 2-13).

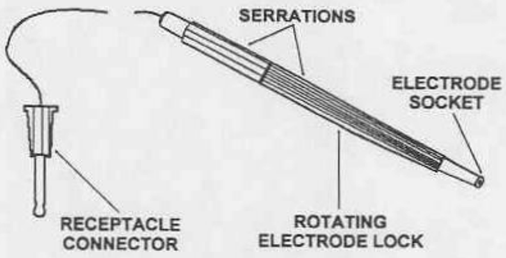


Figure 2-13. Surgical handle with cable assembly.

NOTE

The surgical handle is only footswitch activated.

a. Installation.

(1) Ensure that the ES apparatus is not activated or is in the "STDBY" mode by observing that the yellow "STDBY" indicator is illuminated. If not, depress the white "STDBY" keyboard switch.

(2) Insert the required electrode by twisting the barrel of the surgical handle one turn counterclockwise to open the chuck. Then, grasp the electrode by the insulating sleeve and push its round shank into the surgical handle chuck until the insulating sleeve is inserted. Then twist the handle barrel clockwise until snug to hold the electrode.

WARNING

Do not use an electrode if the shank or insulating sleeve of the electrode does not fit or if the sleeve does not insert to the specified depth. This will prevent injury to the patient or operating room personnel because of arcing between the electrode and handle connection.

(3) Plug the surgical handle cable assembly connector into the "MONOPOLAR" "HAND-SWITCH" receptacle.

b. Operation. Refer to this chapter, section IV, for operating instructions.

2-9. Surgical electrodes.

a. Ensure that the accessory is not energized or is in "STDBY" mode by observing that the yellow "STDBY" indicator is illuminated. If not, depress the white "STDBY" keyboard switch.

b. Insert the selected electrode into an accessory by following the procedures for installation of the handswitching pencil (para 2-6a(2)) or surgical handle (para 2-8a(2)).

Section IV. OPERATING INSTRUCTIONS

2-10. General use procedures.

a. Ensure that the ES apparatus is unpacked, assembled, and prepared for operation in accordance with the initial start-up procedures identified in paragraph 2-2.

b. Provide a minimum of 4 inches of air space around the sides and top of the ES apparatus.

NOTE

It is normal for the top and back panel of the ES apparatus to become warm during continuous use for extended periods of time.

2-11. Self-test mode.

a. Verify completion of initial start-up (para 2-2) and general use (para 2-10) procedures.

b. Turn the electrical power on by pulling upward on the toggle switch, located on the back panel of the ES apparatus, to the "|" symbol.

NOTE

The ES apparatus will automatically undergo an internal self-test process. The three digital displays show "8"s, an audible tone sounds (fig 2-14), and 13 indicators illuminate on the control panel (fig 2-15).

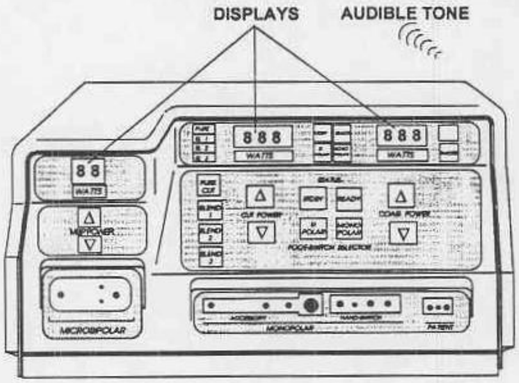


Figure 2-14. Self-test displays.

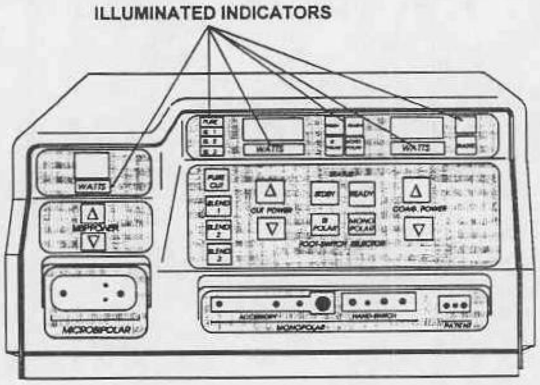


Figure 2-15. Self-test illuminated indicators.

c. Verify the self-test process. If any of the self-test actions do not occur, turn the electrical power toggle switch to the "O" symbol and then back to the "|" symbol to operate the automatic self-test process again.

d. Continue to observe the control panel. The following control panel actions will automatically occur (fig 2-16).

(1) The three digital displays show "- - -."

(2) The yellow "STDBY" indicator illuminates.

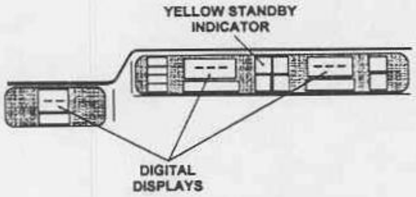


Figure 2-16. Standby mode.

CAUTION

Do not operate the ES apparatus if any of the self-test actions do not occur. Notify your unit Medical Equipment Repairer.

2-12. "READY" mode.

a. Depress the white "READY" keyboard switch.

b. Observe the control panel (fig 2-17) and verify the following actions:

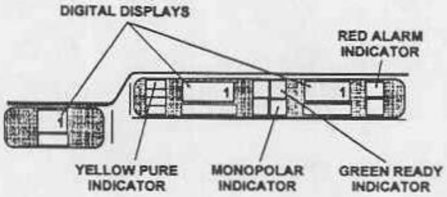


Figure 2-17. Ready mode.

NOTE

Steps (1) and (2) below are valid only when the patient return electrode is disconnected from the "PATIENT" receptacle.

(1) The alarm tone sounds twice.

(2) The red alarm indicator illuminates.

(3) The green "READY" indicator illuminates.

(4) The three digital displays show a "1."

(5) The yellow "MONOPOLAR" indicator illuminates.

(6) The yellow "PURE" indicator illuminates.

CAUTION

Do not operate the ES apparatus if any of the READY mode actions do not occur. Notify your unit Medical Equipment Repairer.

NOTE

The internal microprocessor memory retains the power wattage settings, the footswitch selection, and the selected CUT mode when switched from the "READY" mode to "STANDBY" mode and back to "READY" mode. If the electrical power toggle switch was pushed down to the "O" symbol and back to the "|" symbol, the "MONOPOLAR" indicator and the "PURE" indicator will illuminate.

c. Depress the white keyboard switch to return the ES apparatus to the standby mode until use is required.

NOTE

Observe that the yellow "STDBY" indicator illuminates and the three digital displays show "- - -."

2-13. Selecting modes and power levels.

Depress the white "READY" keyboard switch to activate the ES apparatus. Verify that the green "READY" indicator illuminates.

a. MICROBIPOLAR mode. Set the "MBP POWER" by depressing the blue up (Δ) and down (∇) keyboard switches until the required setting shows in the extreme left-hand digital display. The available wattage for this mode of operation ranges from "1" to "70." A single depression of either switch increases or decreases the digital display setting by 1 watt. Continuous depression of either switch gradually increases or decreases the digital display setting to the maximum or minimum.

NOTE

The initial continuous depression of either keyboard switch until the desired setting is within several digits and then momentarily depressing either switch will allow the desired setting to be obtained rapidly.

b. CUT mode.

(1) Select the CUT mode ("PURE CUT," "BLEND 1," "BLEND 2," or "BLEND 3") by depressing the desired yellow keyboard switch. Observe that the corresponding yellow indicator illuminates.

(2) Set the "CUT POWER" by depressing the yellow up (Δ) and down (∇) keyboard switches until the required setting shows in the center digital display. The available wattage ranges from "1" to "300." A single depression of either switch increases or decreases the digital display setting by 1 watt. Continuous depression of either switch gradually increases or decreases the digital display setting to the maximum or minimum.

NOTE

The initial continuous depression of either keyboard switch until the desired setting is within several digits and then momentarily depressing either switch will allow the desired setting to be obtained rapidly.

(3) Select either the "BIPOLAR" or "MONOPOLAR" foot-switch selector by depressing the desired white keyboard switch. Observe that the selected footswitch indicator illuminates.

c. COAG mode.

(1) Set the "COAG POWER" by depressing the blue up (Δ) and down (∇) keyboard switches until the required setting shows in the right-hand digital display. The available wattage ranges from "1" to "120." A single depression of either switch increases or decreases the digital display setting by 1 watt. Continuous depression of either switch gradually increases or decreases the digital display setting to the maximum or minimum.

(2) Select either the "BIPOLAR" or "MONOPOLAR" "FOOT-SWITCH" selector by depressing the desired white keyboard switch. Observe that the selected footswitch indicator illuminates.

d. Low voltage coagulation.

NOTE

Low voltage coagulation is primarily designed for use with monopolar desiccation. The output power is limited to "99" watts at a reduced voltage.

(1) Depress and hold down the "READY" keyboard switch and then simultaneously depress the blue "COAG POWER" down (∇) keyboard switch.

(2) Observe that the right-hand digital display now shows an "L" in the hundred's digit (left position).

(3) Select either the "BIPOLAR" or "MONOPOLAR" foot-switch selector by depressing the desired white keyboard switch. Observe that the selected footswitch indicator illuminates.

(4) Set the "COAG POWER" by depressing the blue up (Δ) and down (∇) keyboard switches until the required setting shows in the right-hand digital display. The available wattage ranges from "1" to "99." A single depression of either switch increases or decreases the digital display setting by 1 watt. Continuous depression of either switch gradually increases or decreases the digital display setting to the maximum or minimum.

(5) Return to the COAG mode, upon completion of electrosurgery, by depressing and holding down the "READY" switch while simultaneously depressing the "COAG POWER" down (∇) switch.

NOTE

The initial continuous depression of either keyboard switch until the desired setting is within several digits and then momentarily depressing either switch will allow the desired setting to be obtained rapidly.

e. STANDBY mode. Depress the white "STDBY" keyboard switch to return the ES apparatus to the standby mode. Observe that the yellow "STDBY" indicator illuminates.

NOTE

All mode and wattage settings will be retained in the microprocessor memory of the ES apparatus. The indicators and displays will automatically show when the ES apparatus is returned to the "READY" mode.

2-14. Patient return electrode application procedures.

Procedures for applying a patient return electrode are as follows:

a. Select a well vascularized, convex skin surface which is in close proximity to the surgical site.

NOTE

Avoid scar tissue, bony prominences, adipose tissue, and areas where fluids may pool.

b. Shave, clean, and dry the selected surgical site.

NOTE

Do not apply a patient return electrode for a microbipolar procedure. If microbipolar forceps are connected to the "MICROBIPOLAR" receptacle, the alarm indicator will illuminate, but a patient return electrode should not be connected to extinguish the alarm. The microbipolar mode can be safely activated with an alarm condition.

2-15. Typical wattage settings.

a. The wattage used for various surgical procedures varies considerably with a surgeon's technique and the size of the surgical electrode. A needle electrode will require less wattage to sustain a spark that a large ball electrode. Moreover, a surgeon may perform a procedure by electrosurgically severing tissue with cutting or blended waveform. Another surgeon may perform the same procedure by simply desiccating the tissue at a much lower wattage level.

b. A summary of typical power settings are as follows:

(1) Low wattage (<30).

(a) Neurosurgery (microbipolar and monopolar).

(b) Laparoscopic sterilization (microbipolar and monopolar).

(c) Vasectomies.

(d) Dermatology.

(e) Oral surgery.

(f) Plastic surgery.

(2) Medium wattage (COAG: 30 to 70, CUT: 30 to 150).

(a) General surgery.

(b) Laparotomies.

(c) Head and neck (ENT) surgery.

(d) Major orthopedic surgery.

(e) Major vascular surgery.

(f) Routine thoracic surgery.

(g) Polypectomy.

(3) High wattage (COAG:)70, CUT:)150).

(a) Transurethral resections.

(b) Thoracotomies.

(c) Ablative cancer surgery, mastectomies, etc.

WARNING

Special precautions should be taken when using electrosurgery in close proximity to or in direct contact with any metal objects including Gomco clamps, Kocher clamps, and hemostats. Such electrosurgical use, particularly over prolonged periods of time, could result in unintentional and unwanted tissue destruction and burns.

Accessories must be connected to the proper receptacle. In particular, bipolar accessories must be connected only to the "MICROBIPOLAR" receptacle. Improper connection of accessories may result in an inadvertent ES apparatus activation and patient or operating room personnel injury.

NOTE

If the proper wattage is not known from personal experience, the surgeon should start with a very low setting and cautiously increase the wattage until the desired effect is achieved.

Failure of the ES apparatus to produce the desired effect at normal wattage settings may indicate faulty application of the patient return electrode or failure of an accessory cable. Do not increase wattage settings before checking for problems with accessory cables or misapplication of the patient return electrode. Effective contact between the patient and the patient return electrode should be verified if a patient is repositioned after the initial application of the electrode.

2-16. Changing wattage settings.

Procedures to change the wattage settings during a surgical procedure are as follows:

NOTE

Controls on the front panel are disabled when an accessory is activated.

a. Deactivate the footswitch or handswitch being used.

b. Depress the appropriate "MBP POWER," "CUT POWER," or "COAG POWER" up (Δ) or down (∇) keyboard switch until the required setting shows in the applicable digital display.

c. Resume the surgical procedure.

2-17. Safety recommendations during surgery.

Recommended safety actions during surgical procedures are as follows:

a. Keep wattage settings as low as practical to enhance patient and operating room personnel safety.

b. Remove eschar accumulation from electrodes to maintain the surgical effect.

c. Avoid unnecessary and prolonged activation of the ES apparatus to reduce the possibility of alternate site burns which may be caused by RF leakage currents.

d. Check accessories, accessory cables, and the patient return electrode for proper application and/or continuity if a higher than normal wattage setting is required.

e. Keep accessory cables separated when multiple accessories are used. Do not twist, clamp, or bundle them together.

WARNING

Keep active accessories away from the patient when they are not being used.

Section V. ALARMS

2-18. Alarms.

a. Self-test mode.

(1) The alarm tone sounds once.

(2) The red alarm indicator momentarily illuminates.

b. STANDBY mode.

(1) The alarm tone is silent.

(2) The red alarm indicator is off.

c. READY mode.

NOTE

Steps (1) and (2) below are valid only when the patient return electrode is disconnected from the "PATIENT" receptacle.

(1) The alarm tone momentarily sounds twice.

(2) The red alarm indicator illuminates.

Section VI. OPERATION OF AUXILIARY EQUIPMENT

2-19. Associated support items of equipment.

The ES apparatus requires no associated support items of equipment other than an electrical power generator which is shared with multiple items of surgical equipment for electrical power.

2-20. Associated material.

Associated expendable/consumable material used in conjunction with electrosurgery are identified in other supply publications.

Section VII. CLEANING AND STERILIZING PROCEDURES

2-21. General.

a. The ES apparatus, operating accessories, and footswitches should be clean at all times. Specific cleaning and/or sterilizing procedures are provided for each type of item.

b. Accessories identified as disposable should not be cleaned and reused. These accessories were designed and manufactured to be used only one time.

2-22. ES apparatus.

a. Cleaning.

(1) Turn off the ES apparatus, if on, by depressing the electrical power toggle switch to the "O" symbol and then disconnecting the electrical power cord.

(2) Wipe the control cover, the front and back panels, and the electrical power cord with water, a mild detergent and a damp cloth. Then dry it with a soft cloth.

CAUTION

Do not use caustic, corrosive, or abrasive cleaning materials to prevent marring of stenciling, markings, and decals.

b. Sterilizing. The ES apparatus cannot be sterilized.

2-23. Mobile cart.

a. Cleaning. Clean the mobile cart using standard operating room procedures.

CAUTION

Do not allow mop strands to collect around the casters to prevent rusting and restricted cart movement.

b. Sterilizing. The mobile cart cannot be sterilized.

2-24. Footswitches.

a. Cleaning. Clean both footswitches using standard operating room procedures for surgical equipment.

CAUTION

Do not use caustic, corrosive, abrasive, or hydrocarbon solvent cleaning materials and do not allow fluids to enter the footswitches.

NOTE

The footswitches are splash proof only.

b. Sterilizing. The footswitches cannot be sterilized.

2-25. Handswitching pencil.

a. Cleaning.

(1) Remove and process reusable electrodes in accordance with the procedures in paragraph 2-28. Remove and discard disposable electrodes.

(2) Remove all gross matter (blood, mucus, or tissue) by wiping the entire pencil with a cloth or gauze pad and a mild cleaning solution or blood dissolving agent.

(3) Remove any cleaning agent by wiping the pencil with a water dampened cloth.

CAUTION

Do not immerse the pencil in solutions.

NOTE

The pencil should be processed with other delicate surgical instruments to protect the electronic components.

(4) Dry thoroughly with a soft cloth.

*b. Sterilizing (ethylene oxide (*EtO)).

(1) Insert the pencil body, cable, and connector into an EtO pouch after loosely coiling the cable.

CAUTION

Tight coiling, bunching, or wrapping of the cable decreases the useful life of the pencil.

(2) Use standard hospital procedures for EtO sterilization.

c. Sterilizing (steam).

(1) Lay the handswitching pencil in the center of the wrapping material as illustrated in figure 2-18.

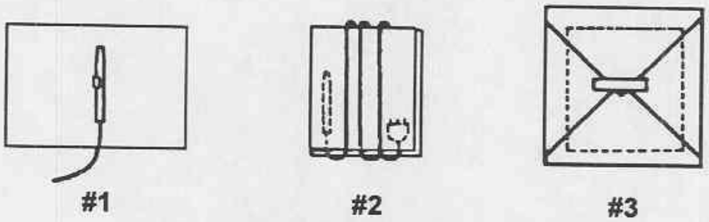


Figure 2-18. Wrapping sequence.

(2) Fold the material over the pencil body and then coil the cable lengthwise around the material.

CAUTION

The pencil body, cable, and connector should not contact each other to prolong the useful life of the pencil.

NOTE

Do not use rubber bands, string, or tape to secure the cable.

(3) Apply another cloth wrapper to the packet arranged in the preceding procedure.

(4) Sterilize the pencil in accordance with standard hospital procedures.

CAUTION

Do not exceed a processing temperature of 135°C (275°F) for 20 minutes to prevent decreasing the useful life of the pencil.

NOTE

EtO sterilization is the recommended method.

2-26. Handswitching forceps.

a. Cleaning.

(1) Remove all matter (blood, mucus, or tissue) by wiping the entire forceps with a cloth or gauze pad and a mild cleaning solution or blood dissolving agent.

(2) Remove any cleaning agent by wiping the forceps with a water dampened cloth.

(3) Inspect the forceps for contamination on the electrical switch contacts located between the tines.

(4) Polish the electrical switch contacts, if required.

(5) Wrap the forceps.

b. Sterilizing. Use standard hospital EtO or steam sterilization procedures.

CAUTION

Do not exceed a processing temperature of 135°C (275°F) for 20 minutes to prevent decreasing the useful life of the forceps.

2-27. Patient return electrode.

a. Cleaning.

(1) Clean the electrode using any hospital-grade detergent and a damp cloth.

CAUTION

Do not use caustic, corrosive, or abrasive cleaning materials to prevent damage to the electrode.

(2) Dry the electrode thoroughly with a soft cloth.

b. Sterilizing. The patient return electrode does not require sterilization.

2-28. Surgical handle(s), electrode(s), and accessory cables.

a. Cleaning.

(1) Removal all matter (blood, mucus, or tissue) by wiping the surgical handle(s), cable(s), or electrodes with a cloth or gauze pad and a mild cleaning solution or blood dissolving agent.

(2) Remove any cleaning agent by wiping them with a water dampened cloth.

(3) Wrap the surgical handle(s) and cable(s).

b. Sterilizing. Use standard hospital EtO or steam sterilization procedures.

CAUTION

Do not exceed a processing temperature of 135°C (275°F) for 20 minutes to prevent decreasing the useful life of the surgical handle(s) or cable(s).

Section VIII. OPERATION UNDER UNUSUAL CONDITIONS

2-29. General.

A more frequent interval of PMCS may be required when operating the ES apparatus under unusual conditions such as very humid and/or dusty environments.

2-30. Operating environments.

The ES apparatus is only designed for use in controlled environments. Refer to table 1-3 for operating ranges.

CHAPTER 3

UNIT LEVEL MAINTENANCE

Section I. GENERAL INFORMATION

3-1. Overview.

a. *Unit level maintenance.* This level of maintenance is the responsibility of and performed by a using unit on its assigned equipment. Responsibilities are stratified as follows:

(1) *Operator maintenance.* This segment of unit level maintenance is performed by operator/user personnel and consists of equipment operational functions; routine services like cleaning, dusting, washing, checking for frayed cables, and stowing items not in use; and checking for loose hardware, replacing operator accessories, and replacing operator repair parts. Replacing operator parts will not require extensive disassembly or assembly of the end item, critical adjustments after replacement, or the extensive use of tools.

(2) *Specialist maintenance.* This segment of unit level maintenance is performed only by trained Medical Equipment Repairers. The functions and services include—

(a) Scheduling and performing PMCS, electrical safety inspections and tests, and calibration/verification/certification (CVC) services.

(b) Performing unscheduled maintenance functions with emphasis on replacing assemblies, modules, and PCBs, when available.

(c) Operating a repair parts program to include Class VIII repair parts as well as other commodity class repair parts used on medical equipment.

(d) Maintaining a library of technical manuals (TMs), manufacturers' literature, repair parts information, and related materials.

(e) Conducting inspections on new or transferred equipment.

(f) Establishing administrative procedures for the control and administration of maintenance services in accordance with TB 38-750-2.

(g) Notifying support maintenance battalions of requirements and/or evacuating unserviceable equipment, assemblies, modules, or PCBs.

b. *Maintenance functions.* Maintenance functions, both preventive and corrective, that are beyond the scope of the user are assigned to unit level Medical Equipment Repairer personnel. These personnel will perform the majority of maintenance required for the equipment except for some tasks involving the PCBs, power supplies, shipping/storing chest, and canvas case.

3-2. Tools and test equipment.

Common tools and test equipment required for unit level maintenance of the equipment are listed in appendix B, section III of this manual. Refer to your unit's modified table or organization and equipment (MTOE) for authorized items.

3-3. Components of end item and basic issue items.

Components of end item and basic issue items are listed in appendix C, sections II and III of this manual.

3-4. Expendable supplies.

Expendable and durable supplies and materials required for maintenance of the equipment are listed in appendix D, section II of this manual.

3-5. Repair parts.

Repair parts required for unit level maintenance are listed in appendix E, section II of this manual.

3-6. Special tools.

Special tools required for unit level maintenance of the equipment are listed in appendix E, section III of this manual.

Section II. SERVICE UPON RECEIPT OF EQUIPMENT

3-7. Unpacking the ES apparatus.

The ES apparatus may be initially issued with either commercial packaging or military packaging in a shipping/storing chest and canvas case. If you receive the ES apparatus with commercial packaging, you should request the authorized shipping/storing chest and canvas case from the Commander, U.S. Army Medical Materiel Agency, ATTN: SGMMA-M, Frederick, MD 21702-5001.

a. Commercial packaging.

(1) Open the cardboard unit container and remove the cardboard intermediate containers which are illustrated in figure 3-1.

(2) Unpack the cardboard intermediate containers and verify receipt of the following materiel:

(a) ES apparatus.
(b) Mobile cart.
(c) Electrode, coagulation ball, 7/32 inch.
(d) Electrode, needle, 3/4 inch.
(e) Electrode, straight skin incision blade, 1 inch, 16 each.
(f) Electrode, angled coagulation ball, 3/32 inch.
(g) Electrode, cutting and biopsy loop, 3/8 inch.
(h) Forceps, straight tip, handswitching, reusable, 4-3/4 inch.
(i) Surgical handle with cable assembly.
(j) Forceps, straight tip, handswitching, reusable, 7 inch.
(k) Cable assembly, handswitching forceps.
(l) Pencil, handswitching, reusable.
(m) Conductive gel, 8-ounce tubes, 13 each.
(n) Patient return electrode, disposable, 12 each.
(o) Pencil, handswitching, disposable.
(p) Monopolar footswitch.
(q) Bipolar footswitch.
(r) Patient return electrode, reusable.
(s) Cable assembly, patient return electrode.
(t) Instruction manual, 2 each.
(u) Service manual, 2 each.

NOTE

You may want to temporarily retain the cardboard unit container if you do not have the shipping/storing chest and canvas case. Otherwise, dispose of the cardboard containers.

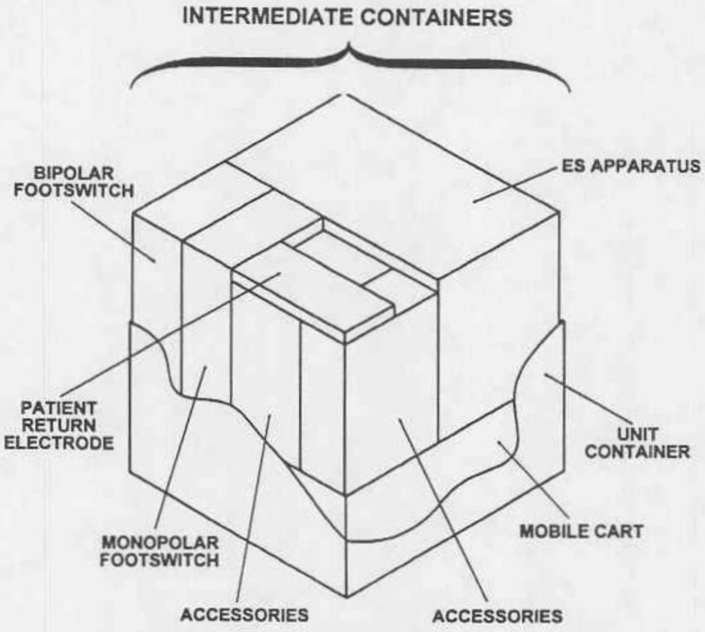

INTERMEDIATE CONTAINERS
BIPOLAR FOOTSWITCH
ES APPARATUS
PATIENT RETURN ELECTRODE
UNIT CONTAINER
MOBILE CART
MONOPOLAR FOOTSWITCH
ACCESSORIES
ACCESSORIES

Figure 3-1. Commercial packaging.

b. Military packaging (chest and canvas case).

(1) Remove any crating or cardboard containers from the shipping/storing chest and canvas case.

(2) Set the shipping/storing chest aside momentarily.

(3) Open the canvas case by pulling apart the hook-and-loop fasteners.

(4) Remove the mobile cart and accessories and set them aside.

(5) Fold the canvas case and store it for future use.

(6) Open the five twist-lock fasteners, located on the front and sides of the shipping/storing chest, and lift open the lid.

NOTE

The hinged lid has a braided wire retaining strap to hold it in an upright position.

(7) Remove the manuals.

(8) Remove the ES apparatus and set it aside.

(9) Remove the bipolar footswitch. Set it aside.

(10) Open the hinged, black metal compartment lid, located inside the chest, and remove the monopolar footswitch. Set it aside.

(11) Close the compartment lid, close the chest lid, lock the twist-lock fasteners, and store the chest until needed.

3-8. Assembling the mobile cart.

The mobile cart may be initially issued with either commercial packaging or military packaging in a canvas case.

a. Commercial packaging.

(1) Open the cardboard container and remove the contents.

(2) Verify receipt of the following material:

(a) Mobile cart.

(b) Casters, 4 each.

(c) Nylon finger screws, 2 each.

(d) Phillips screws, 6 each.

(e) Wing nuts, 6 each.

(f) Washers, 2 each.

(3) Turn the cart over and set it upside down.

(4) Insert the four casters into the sockets on the base of the cart.

(5) Turn the cart over again onto its casters.

(6) Slightly loosen the two front wing nuts (one on each side) attaching the top and the base of the cart together.

(7) Remove the two rear wing nuts and screws, while holding the top of the cart to prevent the top from pivoting downward.

(8) Position the top of the cart to align it with one of three sets of positioning holes for the desired top angle.

NOTE

The center position is at 10 degrees and the other two positions allow an 8- or 12-degree top angle.

(9) Install the two rear wing nuts and screws, removed in a preceding step, and also install two additional wing nuts and screws.

(10) Tighten all six wing nuts and screws.

b. Military packaging (canvas case).

(1) Remove the wooden crate and cardboard container, if required.

(2) Set the canvas case down with the white arrow markings pointing upward.

(3) Open the flap of the case fastened on three edges with hook-and-loop straps. Allow the flap to rest on the floor.

(4) Open the top flap of the case fastened on two edges with hook-and-loop straps.

(5) Remove the accessories stored on the mobile cart shelves.

(6) Pull the mobile cart out of the case. Install the casters and set it upright on the casters.

(7) Fold the canvas case and store it for future use.

CAUTION

Ensure that the canvas case is clean and dry before storing it to prevent mildew or mold.

3-9. Mounting the ES apparatus.

Mount the ES apparatus on the mobile cart by completing the following procedures:

NOTE

Ensure that the adjustable position top of the mobile cart is secured at the desired angle.

a. Turn the ES apparatus up onto its back feet and remove two of the bottom rubber feet and rubber collars from opposite corners. Set the rubber collars temporarily aside and store the two rubber feet for future use.

b. Locate the two fender washers and nylon finger screws.

c. Place the two rubber collars, removed in a preceding step, over the rubber grommets installed into the top of the mobile cart.

d. Align the ES apparatus over the four rubber grommets and set it down.

e. Insert the nylon finger screws through the fender washers and attach the ES apparatus to the mobile cart using the threaded studs exposed when the bottom rubber feet were removed.

CAUTION

Use only finger pressure to tighten the nylon finger screws to prevent stripping their threads.

3-10. Assembling the ES apparatus.

Complete assembly of the ES apparatus and prepare it for operation by following the procedures and instructions in chapter 2, sections II, III, and IV.

CAUTION

Components, accessories, and electrodes not required for a specific electrosurgical procedure should be returned to the shipping/storing chest or an alternate storage location to prevent damage or loss.

Section III. LUBRICATION INSTRUCTIONS

3-11. General.

No lubrication of the ES apparatus is required.

Section IV. PREVENTIVE MAINTENANCE CHECKS AND SERVICES

3-12. General.

a. The ES apparatus must be inspected and serviced systematically to ensure that it is ready for operation at all times. Inspection will allow defects to be discovered and corrected before they result in serious damage or failure.

b. Table 3-1 contains a list of items to be performed by unit level operator/user personnel. This PMCS table is also referred to as "-10 PMCS" requirements. Preventive maintenance by operator/user personnel is not limited to performing the checks and services listed in table 3-1. There are things operator/user personnel should do any time they need to be done, such as checking general cleanliness, observing for improper operational indicators, and maintaining the proper quantities of accessories and electrodes.

c. Table 3-2 contains a list of items to be performed by unit level Medical Equipment Repairers. This PMCS table is also referred to as "-20 PMCS" requirements.

d. Some items to be inspected will be listed in both table 3-1 and table 3-2 to stress their importance, to provide a quality control check on multiple operator/user personnel, and to identify more comprehensive procedures to be accomplished by unit level Medical Equipment Repairers.

e. The following is a list of both PMCS table column headings with a description of the information found in each column:

(1) *Item No.* This column shows the sequence in which to do the PMCS, and is used to identify the equipment area on the Equipment Inspection and Maintenance Worksheet, DA Form 2404.

(2) *Interval.* This column shows when each PMCS item to be serviced: **B** - Before Operation, **D** - During Operation, **A** - After Operation, **Q** - Quarterly, and **S** - Semiannually. **B**, **D**, and **A** should be performed with daily use of the equipment.

NOTE

When the ES apparatus must be kept in continuous operation, check and service only those items that will not disrupt operation. Perform the complete daily checks and services when the equipment can be shut down.

(3) *Item to be Inspected and Procedure.* This column identifies the general area or specific part to be checked or serviced.

(4) *Equipment is not Ready/Available If:*. This column lists conditions that make the equipment unavailable or unusable.

Table 3-1. Operator preventive maintenance checks and services.

ITEM NO	INTERVAL					ITEM TO BE INSPECTED AND PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	Q	S		
1				X		**ES apparatus.**	
						a. Ensure that all components, accessories, and electrodes are on hand using appendix C for inventorying.	Missing components, accessories, or electrodes prevent operation or the ES apparatus.
						b. Check for broken or damaged keyboard switches, indicators, displays, and receptacles.	Broken or damaged controls prevent operation of the ES apparatus.
2				X		**Shipping/storing chest.**	
						a. Inspect for cracks, indentations, or puncture holes.	Chest damage prevents protective storage or safe movement.
						b. Check for loose, bent, or broken. latches.	Unserviceable latches prevent safe movement.
3				X		**Mobile cart.** Check for dents, missing, or nonswiveling casters, missing rubber grommets, or loose/missing hardware.	Missing components prevent safe operation of the ES apparatus.
4	X		X	X		**Monopolar footswitch.**	
						a. Inspect the footswitch for exposed wires or other visible damage.	Damage to the footswitch prevents operation in the monopolar mode.
						b. Verify that the electrical connector can be fastened to its receptacle on the rear panel of the ES apparatus.	Damage or excessive wear of the electrical connectors prevents operation in the monopolar mode.
						c. Rest one hand on the "CUT" pedal while slowly depressing and releasing the "COAG" pedal up and down three times. **NOTE** No movement should be felt in the "CUT" pedal.	Binding or hesitation in the pedal movement or movement felt in the "CUT" pedal causes questionable output or unsafe operation.
						d. Rest one hand on the "COAG" pedal while slowly depressing and releasing the "CUT" pedal up and down three times. **NOTE** No movement should be felt in the "COAG" pedal.	Binding or hesitation in the pedal movement or movement felt in the "COAG" pedal causes questionable output or unsafe operation.
						e. Set up the ES apparatus for operation. Activate the "CUT" and "COAG" pedals separately to verify the correct mode is energized.	The correct mode is not activated.

Table 3-1. Operator preventive maintenance checks and services - continued.

ITEM NO	INTERVAL					ITEM TO BE INSPECTED AND PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	Q	S		
5	X		X	X		**Bipolar footswitch.**	
						a. Inspect the footswitch for exposed wires or other visible damage.	Damage to the footswitch prevents operation in the bipolar mode.
						b. Verify that the electrical connector can be fastened to its receptacle on the rear panel of the ES apparatus.	Damage or excessive wear of the electrical connectors prevents operation in the bipolar mode.
						c. Set up the ES apparatus for operation Activate the pedal to verify that the correct mode is activated.	The correct mode is not activated.
6	X	X		X		**Handswitching pencil (reusable).**	
						a. Check the pencil for cuts, deterioration, fraying, and a worn or broken connector.	A worn or damaged pencil prevents that mode of operation.
						b. Ensure that electrodes fit tightly into the pencil.	Electrodes do not fit tightly into the pencil which prevents that mode of operation.
						c. Set up the ES apparatus for operation. Activate the pencil rocker switch to the "CUT" and "COAG" positions to verify that the correct mode is activated.	The correct mode is not activated.

NOTE

Depressing the yellow "CUT" side of the rocker switch will activate the CUT "WATTS" indicator. Likewise, depressing the "COAG" side of the rocker switch will activate the COAG "WATTS" indicator. If the incorrect indicator illuminates, neither indicator illuminates, or both indicators illuminate, discard the pencil.

ITEM NO	B	D	A	Q	S	ITEM TO BE INSPECTED AND PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
7	X		X	X		**Patient return electrode (reusable).** Inspect the electrode for corrosion, major dents or deformation, and damaged cable studs.	The condition of the electrode causes poor patient contact or no patient contact.
8	X			X		**Patient return electrode cable assembly**. Check the cable assembly for cuts, fraying, deterioration, and worn or broken connectors.	Damage to the cable assembly prevents operation in the monopolar mode.
9	X		X	X		**Surgical electrodes.** Check the electrodes for dirt, corrosion, and worn or bent operating edges or shanks.	The condition of the electrode(s) prevents the required electrosurgical procedure(s).

Table 3-1. Operator preventive maintenance checks and services - continued.

ITEM NO	INTERVAL					ITEM TO BE INSPECTED AND PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	Q	S		
10	X		X	X		**Handswitching forceps.**	
						a. Inspect the forceps for dirt, corrosion, and a worn or damaged connector.	The condition of the forceps prevents the required electrosurgical procedure(s).
						b. Inspect the forceps for proper tip alignment.	The condition of the forceps prevents the required electrosurgical procedure(s).
11	X		X	X		**Handswitching forceps cable assembly**. Inspect the cable assembly for cuts, fraying, deterioration, and worn or broken connectors.	Damage or extensive wear prevents the required electrosurgical procedure(s).
12	X		X	X		**Surgical handle.**	
						a. Inspect the handle for dirt, corrosion, worn, or damaged body components, and a worn electrode holder.	The condition of the handle prevents the required electrosurgical procedure(s).
						b. Check the cable assembly for cuts, fraying, deterioration, and a worn or damaged connector.	Worn or damaged cable assembly prevents the required electrosurgical procedure(s).

Table 3-2. Repairer preventive maintenance checks and services.

ITEM NO	INTERVAL					ITEM TO BE INSPECTED AND PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	Q	S		
1					X	**ES apparatus.**	
						a. Verify that components, accessories, and electrodes have been inventoried by operator/user personnel.	Missing components, accessories, or electrodes prevent operation of the ES apparatus.
						b. Check for broken, worn, or damaged front and rear panel switches, indicators displays, and receptacles.	Broken, worn, or damaged controls prevent operation of the unit.
						c. Check the electrical power cord assembly for cuts, fraying, deterioration, and a worn or damaged connector.	Worn, damaged, or deteriorated cable assembly prevents safe operation of the ES apparatus.
						d. Verify that electrical safety tests have been completed as scheduled.	Safety deficiencies preclude safe operation.
						e. Check that the electrical power cord and facility electrical power are properly grounded and the polarity is correctly phased.	Grounding or electrical power polarity problems cause unsafe operation.

Table 3-2. Repairer preventive maintenance checks and services - continued.

ITEM NO	INTERVAL					ITEM TO BE INSPECTED AND PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	Q	S		
						f. Verify that the operating environment is free of flammable gases, liquids, and materiels.	Fire or explosion hazard or an unsafe condition exists.
						g. Verify that all output wattages precisely meet the specified ranges.	Wattage variations pose a potential risk of injury to patients.

NOTE

Power ranges are: "MBP" - 1 to 70 "WATTS," "CUT" - 1 to 300 "WATTS," "COAG" - 1 to 120 "WATTS," Low voltage "COAG" - 1 to 99 "WATTS."

ITEM NO	INTERVAL					ITEM TO BE INSPECTED AND PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	Q	S		
						h. Check the fuse and fuse holder for corrosion or damage. Verify the fuse rating.	The condition of the fuseholder and/or fuse prevents operation or this safety device.
						i. Remove dust from the electronic chassis by using air pressure in the range of 9 to 15 psi. Use a small brush to help dislodge debris.	Damaged or corroded components, wires, etc. cause unsafe operation or prevent operation.

WARNING

Disconnect electrical power from the ES apparatus prior to removing the top cover. High voltage is present on the electrical power connector, electrical power switch, and the aluminum heat sinks on the PSRF PCB.

CAUTION

The ES apparatus contains static-sensitive devices. Open the chassis only at a static free work station.

NOTE

Remove the ES apparatus top cover and the plastic electronics cover to access the electronic chassis.

ITEM NO	INTERVAL					ITEM TO BE INSPECTED AND PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	Q	S		
						j. Visually inspect each PCB for corroded, broken, or discolored components.	Damaged or corroded PCBs, components, or wiring prevent operation.
						k. Perform the operational tests identified in chapter 3, section V.	The tests indicate a specific mode or overall malfunction.
2				X		**Shipping/storing chest.** Inspect the interior foam insulation and the ES apparatus for evidence of moisture after exposure to rain or snow.	An unserviceable lid gasket or a crack/puncture allows moisture to cause an electrical hazard or a malfunction.
3				X		**Cable assembly.** Inspect the cable assembly on each accessory for cuts, fraying, deterioration, and worn or broken connectors.	Extensive wear or damage prevents the required electrosurgical procedure(s).

3-13. Reporting deficiencies.

If operator personnel discover problems with the equipment during their "-10 PMCS" that they are unable to correct, they must report them. Refer to TB 38-750-2 and report the deficiency using the proper forms. Consult with your unit level Medical Equipment Repairer if you need assistance.

Section V. OPERATIONAL TESTING

3-14. General.

This section contains procedures and test results for operational testing of the ES apparatus, monopolar output wattage, bipolar output wattage, and the alarm system. In addition, test procedures for current leakage and ground integrity are provided.

3-15. Self-test.

a. Perform the initial start-up procedures (para 2-2).

b. Pull the electrical power toggle switch, located on the back panel of the ES apparatus, up to the "|" symbol.

NOTE

The ES apparatus will automatically undergo an internal self-test process.

c. Observe the control panel. The following control panel actions will automatically occur (fig 3-2 and fig 3-3):

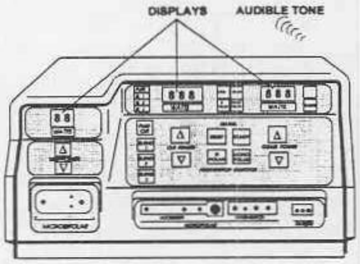


Figure 3-2. Self-test displays.

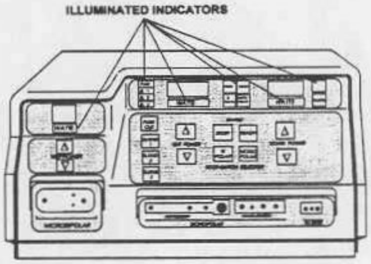


Figure 3-3. Self-test illuminated indicators.

(1) An audible tone momentarily sounds.

(2) The three digital displays show "8"s.

(3) All 13 indicators illuminate.

NOTE

If you did not observe all 13 indicators illuminated, push the toggle switch back down to the "O" symbol and then back up to the "|" symbol.

The ES apparatus automatically switches to the "STDBY" mode after 5 to 7 seconds.

d. Continue to observe the control panel. The following control panel actions will automatically occur (fig 3-4):

(1) The three digital displays show "- - -."

(2) The yellow "STDBY" indicator illuminates.

e. Push the electrical power toggle switch, located on the back panel of the ES apparatus, down to the "O" symbol.

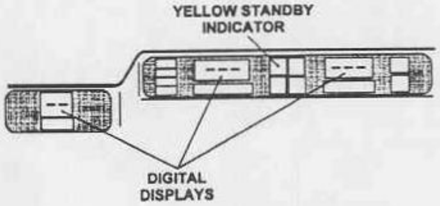


Figure 3-4. Standby mode.

3-16. Monopolar watts test.

a. Perform the initial start-up procedures (para 2-2).

b. Pull the electrical power toggle switch, located on the back panel of the ES apparatus, up to the "|" symbol.

c. Set up a test circuit as depicted in figure 3-5.

NOTE

Output watts versus the digital watts display will be ±15 percent.

d. Set the "COAG" digital display to 50 "WATTS."

e. Activate the "COAG" mode and verify the output watts.

f. Set the "COAG" digital display to 120 "WATTS."

g. Activate the "COAG" mode and verify the output watts.

h. Set the "PURE" "CUT" digital display to 50 "WATTS."

i. Activate the "PURE" "CUT" mode and verify the output watts.

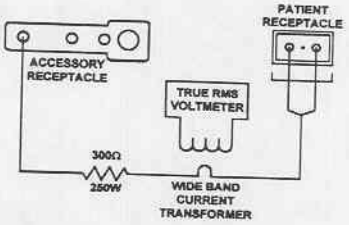


Figure 3-5. Monopolar output test circuit.

j. Set the "PURE" "CUT" digital display to 300 "WATTS."

k. Activate the "PURE" "CUT" mode and verify the output watts.

l. Set the "BLEND 2" "CUT" digital display to 50 "WATTS."

m. Activate the "BLEND 2" "CUT" mode and verify the output watts.

n. Set the "BLEND 2" "CUT" digital display to 200 "WATTS."

o. Activate the "BLEND 2" "CUT" mode and verify the output watts.

p. Disconnect the test circuit.

q. Push the electrical power toggle switch, located on the back panel of the ES apparatus, to the "O" symbol.

3-17. Microbipolar watts test.

a. Perform the initial start-up procedures (para 2-2).

b. Pull the electrical power toggle switch, located on the back panel of the ES apparatus, up to the "|" symbol.

c. Set up a test circuit as depicted in figure 3-6.

NOTE

Output watts versus the digital display will be ±15 percent.

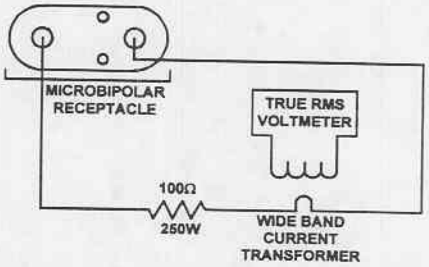


Figure 3-6. Microbipolar output test circuit.

d. Set the "MBP" digital display to 70 "WATTS."

e. Activate the "MBP" mode and verify the output watts.

f. Disconnect the test circuit.

g. Push the electrical power toggle switch, located on the back panel of the ES apparatus, to the "O" symbol.

3-18. Alarm test.

a. Perform the initial start-up procedures (para 2-2).

b. Pull the electrical power toggle switch, located on the back panel of the ES apparatus, up to the "|" symbol.

c. Set up a test circuit as depicted in figure 3-7.

d. Adjust the variable resistor to approximately 30 ohms.

e. Verify that the red alarm indicator is illuminated and the alarm tone sounds twice.

f. Slowly decrease the variable resistor value and verify that the red alarm indicator is not illuminated when the resistance is approximately 18 ohms.

g. Disconnect the test circuit.

h. Push the electrical power toggle switch, located on the back panel of the ES apparatus, to the "O" symbol.

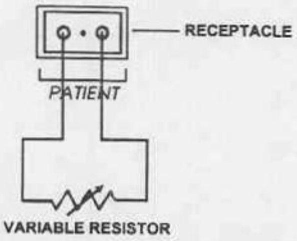

RECEPTACLE
PATIENT
VARIABLE RESISTOR

Figure 3-7. Alarm test circuit.

3-19. Electrical current leakage test (50/60 Hz).

a. Perform the initial start-up procedures (para 2-2).

b. Pull the electrical power toggle switch, located on the back panel of the ES apparatus, up to the "|" symbol.

c. Set up a test circuit as depicted in figure 3-8.

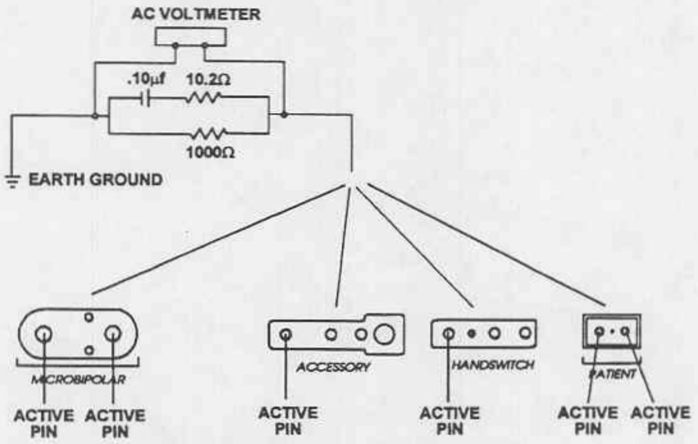

AC VOLTMETER
.10µf
10.2Ω
1000Ω
EARTH GROUND
MICROBIPOLAR
ACTIVE PIN
ACTIVE PIN
ACCESSORY
ACTIVE PIN
HANDSWITCH
ACTIVE PIN
PATIENT
ACTIVE PIN
ACTIVE PIN

Figure 3-8. Electrical leakage test circuit.

NOTE

These measurements can be made with a standard current leakage tester provided that the instructions from the tester manufacturer are closely followed.

d. Measure the electrical leakage current from each active pin of all front panel receptacles by observing the voltage developed across the test circuit to earth ground. Record the voltages.

e. Calculate the leakage current using the formula I = E/R where I = current, E = voltage, and R = resistance.

NOTE

The maximum acceptable voltage across the 1 kilohm resistor for 2.0 microamperes is 0.002 volts (2 millivolts).

f. Measure the ES apparatus leakage current by opening the green grounding wire at the electrical power connector and connecting the test circuit from the ES apparatus to the electrical receptacle ground pin.

NOTE

The maximum acceptable voltage across the test circuit for 100 microamperes leakage will be 100 millivolts.

g. Disconnect the test circuit.

h. Push the electrical power toggle switch, located on the back panel of the ES apparatus, to the "O" symbol.

Section VI. MAJOR ASSEMBLY, PCB, AND COMPONENT LOCATIONS/INTERCONNECTIONS

3-20. General.

This section uses pictorials to illustrate the location and interconnections of assemblies, PCBs, and major components. Their locations are depicted in figure 3-9.

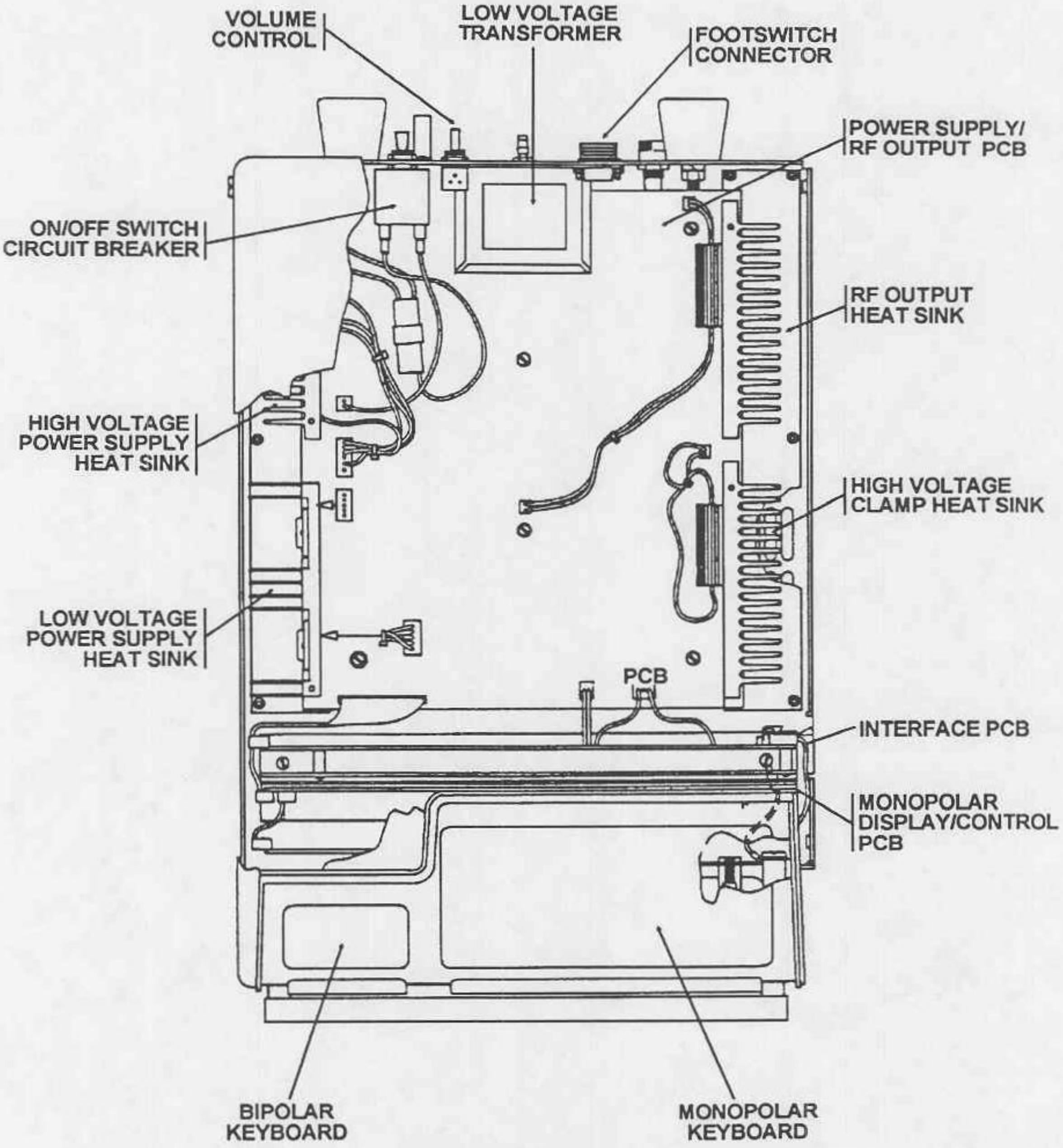

VOLUME CONTROL
LOW VOLTAGE TRANSFORMER
FOOTSWITCH CONNECTOR
POWER SUPPLY/ RF OUTPUT PCB
ON/OFF SWITCH CIRCUIT BREAKER
RF OUTPUT HEAT SINK
HIGH VOLTAGE POWER SUPPLY HEAT SINK
HIGH VOLTAGE CLAMP HEAT SINK
LOW VOLTAGE POWER SUPPLY HEAT SINK
PCB
INTERFACE PCB
MONOPOLAR DISPLAY/CONTROL PCB
BIPOLAR KEYBOARD
MONOPOLAR KEYBOARD

Figure 3-9. Assembly, PCB, and component locations.

3-21. Cabling/wiring interconnections.

a. Cabling/wiring interconnections with electronic plug (P) and jack (J) connectors are identified in figures 3-10 and 3-11.

b. Call-outs associated with each set of connectors (fig 3-10 and fig 3-11) are used to identify their pin functions in table 3-3.

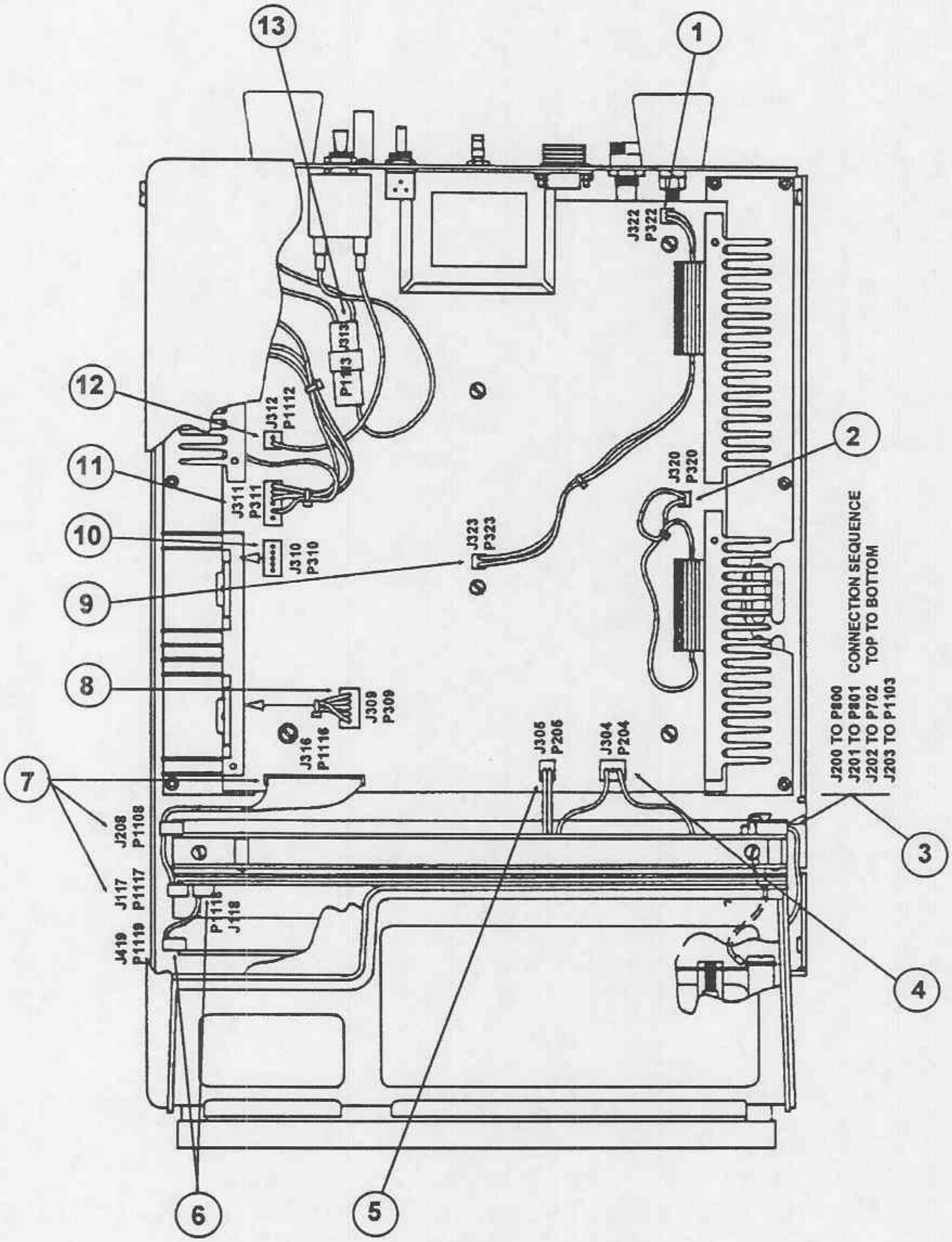

13
1
J322
P322
J313
P1113
12
J312
P1112
11
J311
P311
10
J310
P310
9
J323
P323
2
J320
P320
8
J309
P309
J316
P1116
J305
P205
J304
P204
CONNECTION SEQUENCE
TOP TO BOTTOM
J200 TO P800
J201 TO P801
J202 TO P702
J203 TO P1103
7
J208
P1108
J117
P1117
J419
P1119
P1118
J118
3
4
6
5

Figure 3-10. Cable connectors - view 1.

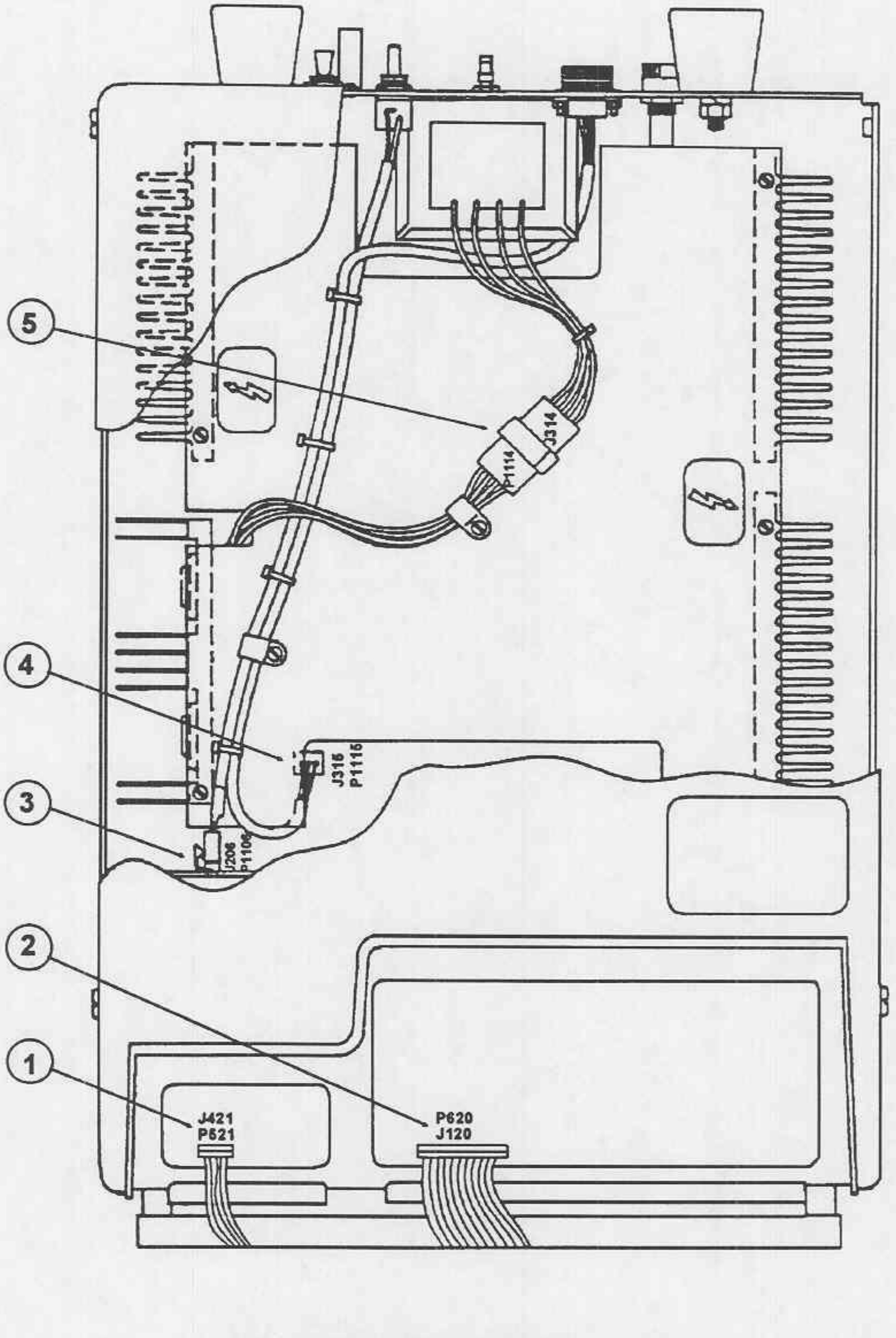

5
J314
P1114
4
J316
P1115
3
J206
P1106
2
1
J421
P521
P620
J120

Figure 3-11. Cable connectors - view 2.

Table 3-3. Connector pin functions.

CABLE CONNECTORS - VIEW 1

CALL-OUT NO.	JACK/PLUG NO.	PIN	FUNCTION
1	J322/P322	1	RF output heat sink
		2	RF output heat sink
2	J320/P320	1	Q5 drain
		2	HV clamp resistor
3	J200/P800	1	handswitch active
		2	handswitch "COAG"
		3	handswitch "CUT"
	J201/P801	1	accessory active
		2	accessory "COAG"
		3	accessory "CUT"
	J202/P702	1	bipolar out 1
		2	bipolar switch
		3	bipolar out 2
	J203/P1103	1	alarm switch 1
		2	alarm switch 2
		3	no connection
		4	no connection
		5	alarm return 1
		6	alarm return 2
4	J304/P204	1	monopolar RF
		2	no connection
		3	RF return
5	J305/P205	1	bipolar RF 1
		2	bipolar RF 2
6	J118/P1118 J419/P1119	1	digit 1
		2	digit 2
		3	segment A
		4	segment B
		5	segment C
		6	segment D
		7	segment E
		8	segment F
		9	segment G
		10	bipolar up
		11	bipolar down
		12	lamp drive
		13	bipolar power
		14	speaker 1
		15	speaker 1
		16	speaker 2
		17	speaker 2
		18	shield
		19	digital ground
		20	digital ground
7	J117/P1117 J208/P1108 J316/P1116	1	digital ground
		2	digital ground
		3	+5 VDC
		4	+5 VDC
		5	+12 VDC
		6	+12 VDC
		7	-5 VDC
		8	analog ground
		9	ECON voltage
		10	ICON voltage
		11	alarm fault
		12	RF sense
		13	no connection
		14	no connection

Table 3-3. Connector pin functions - continued.

		15	volume
		16	volume
		17	no connection
		18	no connection
		19	bipolar enable
		20	"CUT" enable
		21	"COAG" enable
		22	"BLEND" enable
		23	bipolar relay
		24	handswitch relay
		25	accessory relay
		26	"CUT" relay
		27	alarm pulse width
		28	no connection
		29	handswitch "CUT"
		30	handswitch "COAG"
		31	handswitch up/down
		32	accessory switch "CUT"
		33	accessory switch "COAG"
		34	footswitch "CUT"
		35	footswitch "COAG"
		36	bipolar footswitch
		37	no connection
		38	no connection
		39	on
		40	off
8	J309/P309	1	+5 VDC filter capacitor
		2	+12 VDC filter capacitor
		3	low voltage return
		4	+12 VDC
		5	+5 VDC
9	J323/P323	1	RF output heat sink
		2	RF output heat sink
10	J310/P310	1	high voltage DC source
		2	high voltage DC source
		3	high voltage DC snubber
		4	high voltage DC return
		5	high voltage DC position
11	J311/P311	1	line high
		2	line low
		3	line transformer
		4	no connection
		5	line snubber
		6	no connection
12	J312/P1112	1	AC neutral
		2	no connection
13	J313/P1113	1	AC 120 volts
		2	no connection
		3	no connection
CABLE CONNECTORS - VIEW 2			
1	J421/P521	1	shield
		2	digital ground
		3	"BIPOLAR" up switch
		4	"BIPOLAR" down switch
2	J120/P620	1	shield
		2	digital ground
		3	"PURE" "CUT" switch
		4	"BLEND 1" switch
		5	"BLEND 2" switch
		6	"BLEND 3" switch

Table 3-3. Connector pin functions - continued.

		7	"CUT" up switch
		8	"CUT" down switch
		9	"STANDBY" switch
		10	"BIPOLAR" "FOOTSWITCH"
		11	"READY" switch
		12	"MONOPOLAR" "FOOTSWITCH"
		13	"COAG" up switch
		14	"COAG" down switch
3	J206/P1106	1	monopolar footswitch "CUT" D
		2	monopolar footswitch "COAG" A
		3	monopolar footswitch common C
		4	bipolar footswitch common C
		5	bipolar footswitch desicate A
		6	footswitch ground B
4	J315/P1115	1	+12 VDC
		2	volume control
		3	shield ground
5	J314/P1114	1	5 VDC unregulated in
		2	5 VDC return
		3	12 VDC unregulated in
		4	12 VDC unregulated return

Section VII. TROUBLESHOOTING

3-22. General.

a. Troubleshooting information, for ES apparatus operator/user personnel is provided in table 3-4 and troubleshooting information for Medical Equipment Repairers is provided in tables 3-5 through 3-10.

b. This manual cannot list all possible malfunctions. If a malfunction is not listed or is not determined by routine diagnostic procedures, notify your appropriate maintenance support unit.

3-23. Operator/user troubleshooting.

Operator/user troubleshooting procedures in an operating room are provided in table 3-4. Symptoms are provided for probable malfunctions. Each symptom is followed by possible causes and corrective actions.

Table 3-4. Operator/user troubleshooting.

SYMPTOM

POSSIBLE CAUSE

CORRECTIVE MAINTENANCE

1. ALARM ACTIVATES USING A PATIENT RETURN ELECTRODE.

Defective patient return electrode cable assembly.

Replace the cable assembly or request emergency repair services.

Defective patient return electrode.

Replace electrode.

2. ES APPARATUS DOES NOT ACTIVATE (SELF-TEST PASSED).

ES apparatus in "STDBY" mode.

Depress white "READY" keyboard switch.

Table 3-4. Operator/user troubleshooting - continued.

SYMPTOM

- **POSSIBLE CAUSE**
    - **CORRECTIVE MAINTENANCE**

- Defective footswitch or handswitching accessory.
    - Replace footswitch or request emergency repair services.
- Defective patient return electrode.
    - Replace electrode.
- Defective patient return electrode cable assembly.
    - Replace cable assembly.
- Output wattage set too low.
    - Check digital display for watts and adjust as required.

3. ES APPARATUS CAUSES MONITORING EQUIPMENT INTERFERENCE.

- ES apparatus not grounded.
    - Check electrical power cord for deterioration, fraying, or cuts. Request emergency repair services.
- Monitoring equipment not grounded.
    - Check all monitoring equipment cables for deterioration, fraying, or cuts. Request emergency repair services.

4. ES APPARATUS CAUSES INTERFERENCE DURING ACTIVATION.

- ES apparatus not grounded.
    - Check electrical power cord for deterioration, fraying, or cuts. Request emergency repair services.
- Unknown
    - Medical clinicians need to assess the risk of continued ES apparatus operation and proceed with extreme caution or cease operation. Replace the ES apparatus, if possible and notify your Medical Equipment Repairer as soon as possible.

5. NEUROMUSCULAR STIMULATION.

- High output watts.
    - Decrease the watts setting, if possible, or stop the electrosurgical procedure and replace the ES apparatus, if available.
- Defective accessory cable(s).
    - Quickly check all accessory cables and connectors for visible arcing. Stop the electrosurgical procedure if the problem is not quickly corrected. Replace the ES apparatus, if available.
- High electrical current leakage.
    - None immediately. Stop the electrosurgical procedure as soon as safely possible and replace the ES apparatus, if available.

6. PACEMAKER INTERFERENCE.

- Defective accessory cable(s).
    - Quickly check all accessory cable assemblies for visible arcing. Assess the risk of continued operation and proceed with extreme caution or cease operation.

CAUTION

Pacemaker patients will be monitored during ES procedures and a defibrillator will be available to minimize patient risk.

3-24. Medical Equipment Repairer troubleshooting.

a. Perform the initial start-up procedures (para 2-2).

b. Pull the electrical power toggle switch, located on the back panel of the ES apparatus, up to the "|" symbol.

c. Observe the control panel. The following control panel actions will automatically occur (fig 3-12 and fig 3-13).

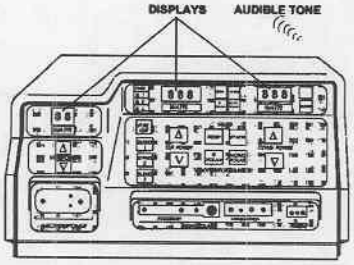


Figure 3-12. Self-test displays.

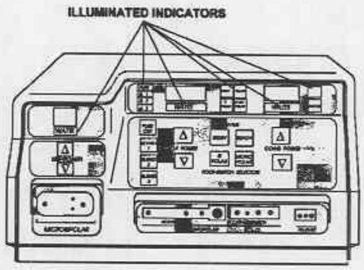


Figure 3-13. Self-test illuminated indicators.

(1) An audible tone momentarily sounds.

(2) The three digital displays show "8"s.

(3) All 13 indicators illuminate.

NOTE

If you did not observe all 13 indicators illuminated, push the electrical power toggle switch back to the "O" symbol and then back again to the "|" symbol.

The ES apparatus automatically switches to the "STDBY" mode after 5 to 7 seconds.

d. Continue to observe the control panel. The following control panel actions will automatically occur (fig 3-14).

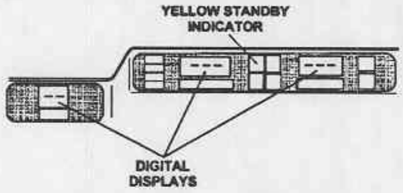


Figure 3-14. Standby mode.

(1) The three digital displays now show "- - -."

(2) The yellow "STDBY" indicator illuminates.

e. If the self-test fails, follow troubleshooting table 3-5 and perform the specified actions.

Table 3-5. Self-test troubleshooting.

SYMPTOM

  POSSIBLE CAUSE

    CORRECTIVE MAINTENANCE

SELF-TEST MODE FAILS TO START WHEN ES APPARATUS IS POWERED UP.

  Electrical power is not connected.

    Connect electrical power.

  Back panel fuse is defective.

    Replace back panel fuse.

Table 3-5. Self-test troubleshooting - continued.

SYMPTOM
- **POSSIBLE CAUSE**
  - **CORRECTIVE MAINTENANCE**

- Low voltage power at J309 - pin 4 is not +12 VDC ±0.02 V and J309 - pin 5 is not -5 VDC ±0.25 V.
  - Replace PSRF PCB.
- Malfunctioning power supply transformers.
  - Notify DS/GS maintenance.
- Bridge rectifiers on low voltage heat sink defective.
  - Notify DS/GS maintenance.
- Oscillator (Y1) on MD/C PCB not operating at 6 MHz.
  - Replace MD/C PCB.

f. If no output is generated in PURE CUT mode set at 150 watts, follow troubleshooting table 3-6 and perform the specified actions.

Table 3-6. PURE CUT output troubleshooting.

SYMPTOM
- **POSSIBLE CAUSE**
  - **CORRECTIVE MAINTENANCE**

NO OUTPUT IS GENERATED IN PURE CUT MODE SET AT 150 WATTS.

- PURE CUT is not activated.
  - Replace PSRF PCB.
- Accessory output does not show 150 watts.
  - Replace PSRF PCB or connector.
- Fuse F1 on PSRF PCB does not have continuity.
  - Replace fuse.
- Defective transistors Q26 through Q29 on PSRF PCB.
  - Replace PCB.
- Transformers T1 and T2 not at 40 kHz.
  - Replace PCB.
- No ramping DC voltage at capacitors C36 and C37 on PSRF PCB when keyboard is activated.
  - Replace PCB.
- Diodes CR1 through CR5 defective on PSRF PCB.
  - Replace PCB.
- RF output FETs Q1 - Q9 on PSRF PCB short circuited.
  - Replace PCB.
- Over current circuit is latched on PSRF PCB.
  - Check for ECON voltage at pin 1, IC U7 on the PSRF PCB. Replace PCB.
- No voltage at transformer TP3 on MD/C PCB.
  - Replace main ribbon cable assembly.

Table 3-6. PURE CUT output troubleshooting - continued.

SYMPTOM
- **POSSIBLE CAUSE**
  - **CORRECTIVE MAINTENANCE**

- No voltage present at IC U27 on MD/C PCB.
  - Replace PCB.
- No 80 kHz signal on pin 12 and pin 16, IC U7.
  - Replace MD/C PCB.
- No 40 kHz signal on pin 13 and pin 16, IC U7.
  - Replace PCB.

g. If the ES apparatus does not activate in CUT, COAG, or BIPOLAR modes when using a monopolar footswitch, follow troubleshooting table 3-7 and perform the specified actions.

Table 3-7. Monopolar footswitch troubleshooting.

SYMPTOM
- **POSSIBLE CAUSE**
  - **CORRECTIVE MAINTENANCE**

UNIT DOES NOT ACTIVATE FOOTSWITCHING OUTPUT IN CUT, COAG, OR BIPOLAR WITH FOOTSWITCH.
- Footswitch assembly does not have continuity.
  - Repair footswitch assembly.
- Capacitor C230 on interface PCB not at +10 VDC.
  - Check transformer T202, diode CR204, or diode CR214 for shorting on the interface PCB. Replace PCB.
- Optoisolators OPT7 through 9 on interface PCB have emitter turned on.
  - Replace PCB.

h. If the ES apparatus does not activate in the CUT or COAG modes when using a handswitching accessory, follow troubleshooting table 3-8 and perform the specified action.

Table 3-8. Monopolar handswitch troubleshooting.

SYMPTOM
- **POSSIBLE CAUSE**
  - **CORRECTIVE MAINTENANCE**

UNIT DOES NOT ACTIVATE HANDSWITCHING OUTPUT IN CUT OR COAG WITH HANDSWITCH.
- Handswitching accessory does not have continuity.
  - Replace handswitching accessory.
- Capacitor C219 on interface PCB not at +10 VDC.
  - Check for 100 kHz signal at transformer TP5, check for shorting of transformer T202, transistor Q4, or diodes CR204 and CR214 on interface PCB.
- Optoisolators OPT4 through 6 on the interface PCB are not turned on.
  - Replace PCB.

i. If the ES apparatus does not activate when using the handswitching forceps, follow troubleshooting table 3-9 and perform the specified actions.

Table 3-9. Handswitching forceps troubleshooting.

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE MAINTENANCE
UNIT DOES NOT ACTIVATE WITH HANDSWITCHING FORCEPS.		
	Bipolar forceps and cable do not have continuity.	Replace cable and forceps.
	Capacitor C216 on interface PCB not at +10 VDC.	Check transformer T2, transistor Q4, or diodes CR215 and CR216 for shorting on the interface PCB. Replace PCB.
	Optpisolator OPT3 on the interface PCB are not turned on.	Replace interface PCB.

j. If the alarm either does not operate or it operates continuously, follow troubleshooting table 3-10 and perform the specified actions.

Table 3-10. Alarm fault troubleshooting.

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE MAINTENANCE
NO ALARM OR CONSTANT ALARM.		
	When the power is off and the patient return electrode is disconnected J203, pin 5 or pin 6, does not have continuity.	Replace patient receptacle.
	When a mode using a patient return electrode is activated, there is an open circuit at J203, pin 5 or pin 6.	Replace patient receptacle.
	Transformer TP3 on interface PCB does not have +2.19 to +4.89 VDC.	Check transformer T3 for continuity. Replace interface PCB.
	J1117, pin 11 to J208, pin 11 is not electronically continuous.	Replace main ribbon cable assembly.
	J117, pin 11 on MD/C PCB does not have +2.19 to +4.89 VDC.	Replace MD/C PCB.

k. Push the electrical power toggle switch, located on the back panel of the ES apparatus, to the "O" symbol.

3-25. Electrical/electronic schematics, diagrams, and graphs.

The schematics, diagrams, and graphs are provided in this paragraph to assist you when troubleshooting. Isolate the problem to a functional segment of the circuitry.

a. Schematics of the monopolar footswitch, bipolar footswitch, monopolar handswitch, bipolar handswitch, and keyboards are provided in figures 3-15 through 3-20. The schematics illustrate their connector electrical orientation.

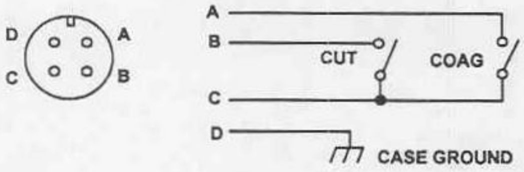

D
A
C
B
A
B
CUT
COAG
C
D
CASE GROUND

Figure 3-15. Monopolar footswitch/connector schematic.

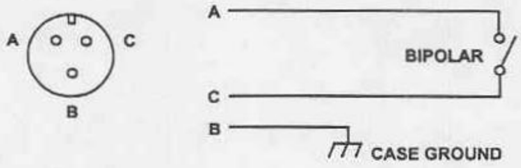

A
C
B
A
BIPOLAR
C
B
CASE GROUND

Figure 3-16. Bipolar footswitch/connector schematic.

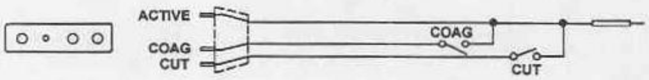

ACTIVE
COAG
CUT
COAG
CUT

Figure 3-17. Monopolar handswitch/connector schematic.

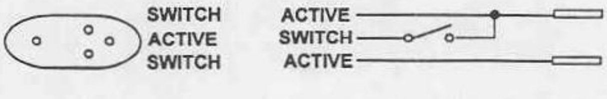

SWITCH
ACTIVE
SWITCH
ACTIVE
SWITCH
ACTIVE

Figure 3-18. Bipolar handswitch/connector schematic.

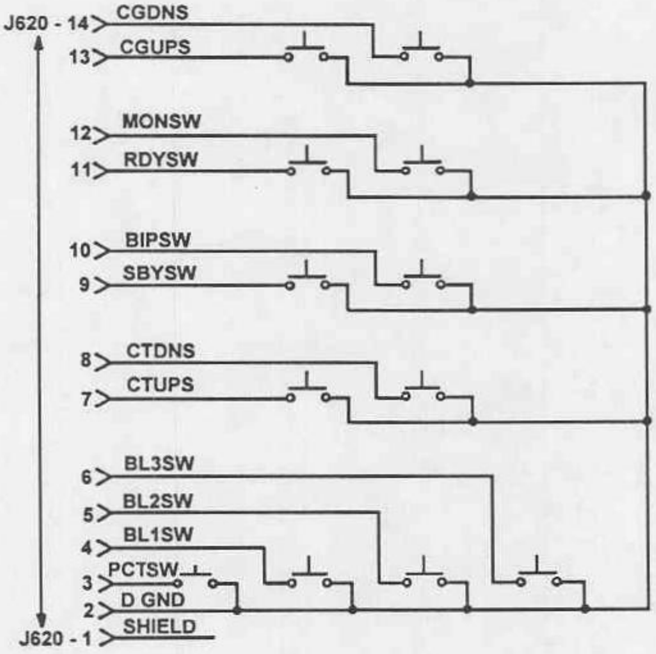

J620 - 14
CGDNS
13
CGUPS
12
MONSW
11
RDYSW
10
BIPSW
9
SBYSW
8
CTDNS
7
CTUPS
6
BL3SW
5
BL2SW
4
BL1SW
3
PCTSW
2
D GND
J620 - 1
SHIELD

Figure 3-19. Monopolar keyboard schematic.

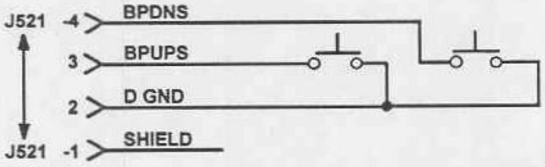

J521 -4
BPDNS
3
BPUPS
2
D GND
J521 -1
SHIELD

Figure 3-20. Bipolar keyboard schematic.

b. The system diagram depicts the relationship between PCBs, switches, operational controls, and other major components. Refer to figure 3-21.

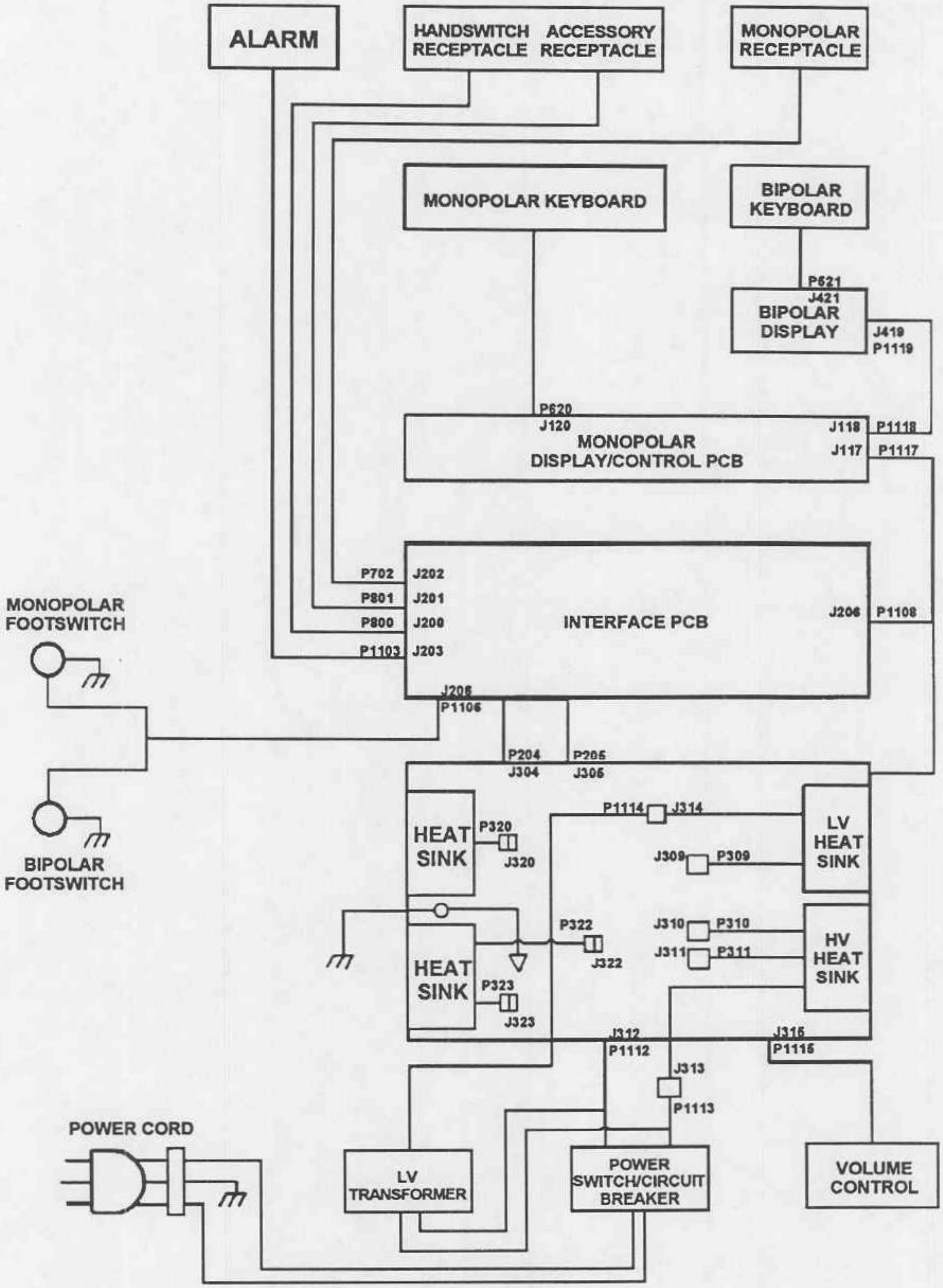

ALARM
HANDSWITCH RECEPTACLE
ACCESSORY RECEPTACLE
MONOPOLAR RECEPTACLE
MONOPOLAR KEYBOARD
BIPOLAR KEYBOARD
P621
J421
BIPOLAR DISPLAY
J419
P1119
P620
J120
MONOPOLAR DISPLAY/CONTROL PCB
J118
P1118
J117
P1117
P702
J202
P801
J201
P800
J200
P1103
J203
INTERFACE PCB
J208
P1108
J206
P1106
MONOPOLAR FOOTSWITCH
BIPOLAR FOOTSWITCH
P204
J304
P205
J305
HEAT SINK
P320
J320
P1114
J314
LV HEAT SINK
J309
P309
P322
J322
J310
P310
J311
P311
HV HEAT SINK
HEAT SINK
P323
J323
J312
P1112
J316
P1116
J313
P1113
POWER CORD
LV TRANSFORMER
POWER SWITCH/CIRCUIT BREAKER
VOLUME CONTROL

Figure 3-21. System diagram.

c. The graphs (fig 3-22 and fig 3-23) portray the ES apparatus output power versus impedance for all seven electrosurgical modes.

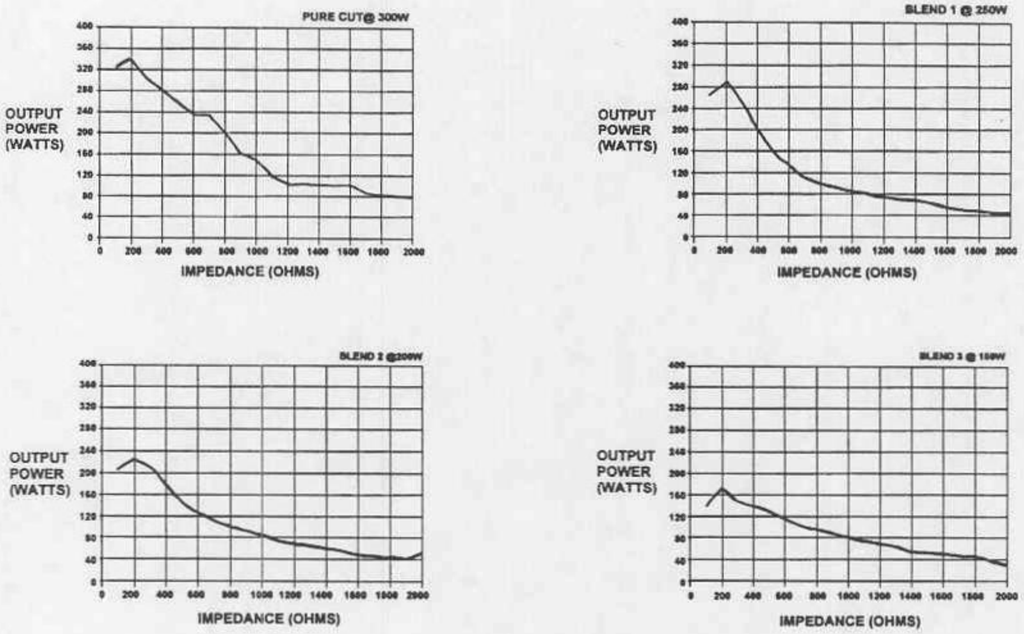


Figure 3-22. CUT waveforms.

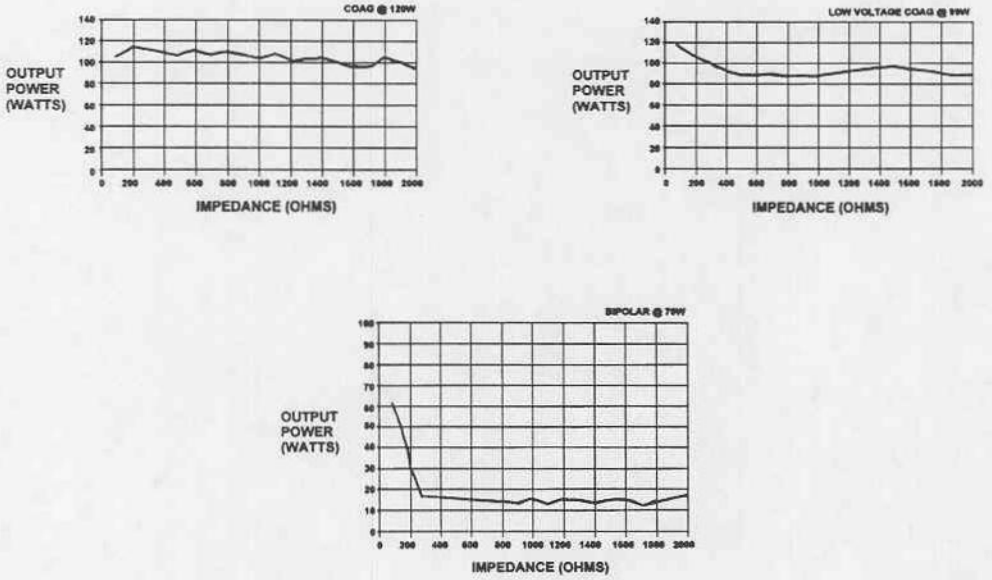


Figure 3-23. COAG and bipolar waveforms.

Section VIII. REPAIR PROCEDURES

3-26. General.

a. Procedures for disassembly, replacement of assemblies, PCBs, major components, and reassembly are provided in this section of the manual.

b. Each repair procedure is continuous from the first disassembly procedure to the final reassembly procedure.

WARNING

The ES apparatus contains hazardous voltages. Ensure that electrical power is off and disconnected.

CAUTION

The ES apparatus contains static-sensitive devices. Use your authorized electrostatic discharge (ESD) workstation identified in appendix D.

c. Test the ES apparatus after completion of each disassembly/maintenance service/reassembly action.

3-27. Control panel assembly (fig 3-24).

a. Disassembly.

(1) Verify that the electrical power toggle switch, located on the back panel of the ES apparatus, is at the "O" symbol. Also verify that the electrical power cord is disconnected from the electrical receptacle.

(2) Remove the four slotted screws and lockwashers fastening the top cover of the ES apparatus to the base assembly. Set them aside.

(3) Remove the top cover by gently rocking it back and forth while simultaneously pulling upward. Set it aside.

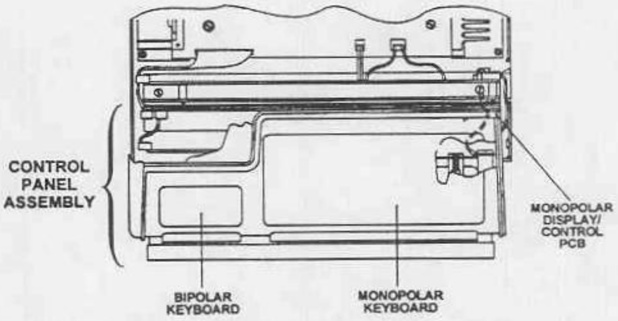


Figure 3-24. Control panel assembly.

(4) Disconnect the following electronic plugs (fig 3-25):

(a) P1117 from J117

(b) P800 from J200

(c) P801 from J201

(d) P702 from J202

(e) P1103 from J203

NOTE

Use a flat blade offset screwdriver to remove the slotted screws in the next two steps.

(5) Remove the slotted screw, holding the green/yellow electrical ground wire with crimped terminal lug and flat washer, from the right-hand handle rod. Set the screw and washer aside.

(6) Remove the slotted screw and flat washer from the left-hand handle rod. Set them aside.

(7) Pull out the handle to remove it. Set it aside.

(8) Remove the two slotted screws, located on the bottom of the ES apparatus, attaching the RF shield bracket to the base assembly. Set them aside.

(9) Remove the three hex socket screws from the lower front of the control panel assembly. Set them aside.

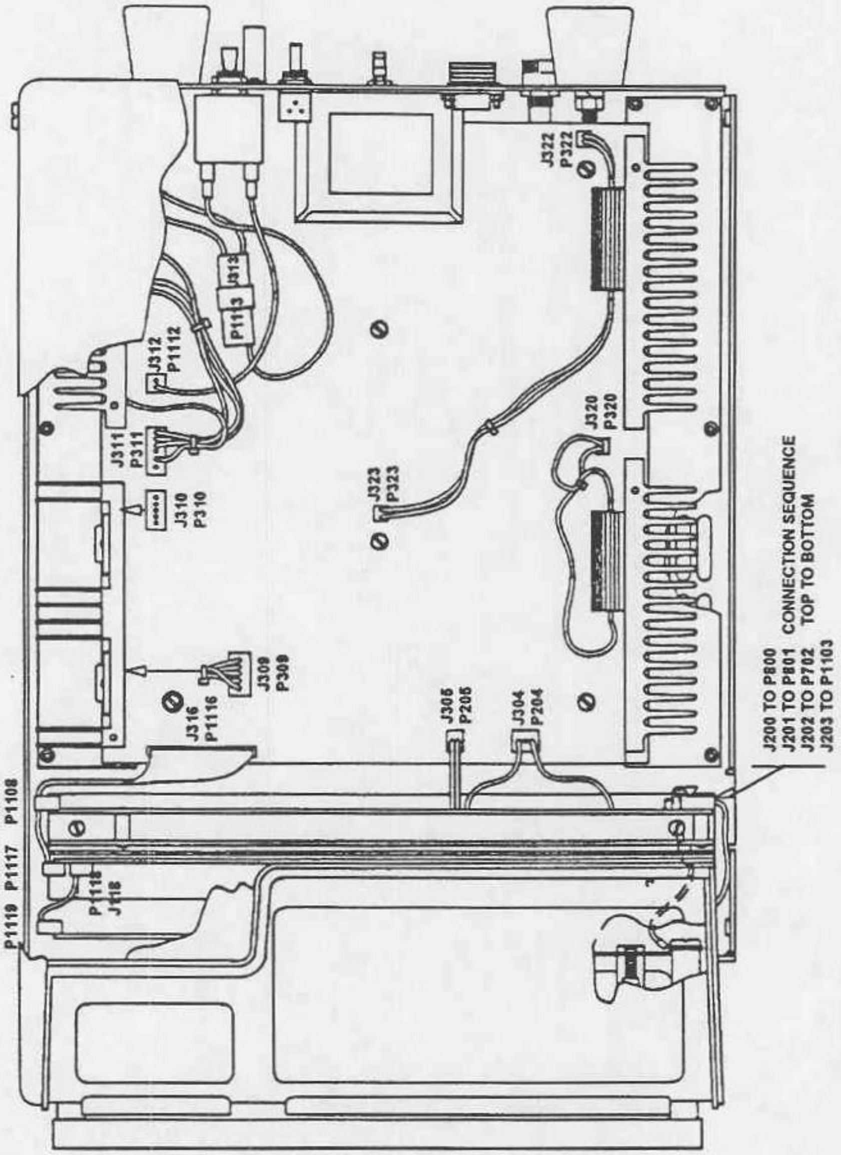

J322
P322
J313
P1113
J312
P1112
J311
P311
J310
P310
J323
P323
J320
P320
J309
P308
J316
P1116
J305
P205
J304
P204
CONNECTION SEQUENCE
TOP TO BOTTOM
J200 TO P800
J201 TO P801
J202 TO P702
J203 TO P1103
J208
P1108
J117
P1117
J419
P1119
P118
J118

Figure 3-25. Connectors - view 1.

(10) Detach the control panel assembly from the base assembly.

b. Maintenance service. Perform the required service.

c. Reassembly.

(1) Position the control panel assembly onto the base assembly.

(2) Reinstall the three hex socket screws into the lower front of the control panel assembly to fasten it to the base assembly.

(3) Reinstall the two slotted screws through the base assembly and into the RF shield bracket.

(4) Reinstall the handle.

(5) Reinstall the slotted screw and flat washer into the left-hand handle rod.

(6) Insert the slotted screw through the crimped terminal lug of the green/yellow electrical ground wire and then the flat washer. Reinstall the screw into the right-hand handle rod.

(7) Reconnect the following electronic plugs. (Refer to figure 3-25.)

(a) P1117 to J117

(b) P800 to J200

(c) P801 to J201

(d) P702 to J202

(e) P1103 to J203

(8) Reinstall the top cover and refasten it with the four slotted screws and lockwashers.

3-28. Monopolar display/control PCB (fig 3-26).

a. Disassembly.

(1) Verify that the electrical power toggle switch, located on the back panel of the ES apparatus, is at the "O" symbol. Also verify that the electrical power cord is disconnected from the electrical receptacle.

(2) Remove the four slotted screws and lockwashers fastening the top cover of the ES apparatus to the base assembly. Set them aside.

(3) Remove the top cover by gently rocking it back and forth while simultaneously pulling upward. Set it aside.

(4) Disconnect the following electronic plugs. (Refer back to figure 3-25.)

(a) P1117 from J117

(b) P800 from J200

(c) P801 from J201

(d) P702 from J202

(e) P1103 from J203

NOTE

Use a flat blade offset screwdriver to remove the slotted screws in the next two steps.

(5) Remove the slotted screw, holding the green/yellow electrical ground wire with crimped terminal lug and flat washer, from the right-hand handle rod. Set the screw and washer aside.

(6) Remove the slotted screw and flat washer from the left-hand handle rod. Set them aside.

(7) Pull out the handle to remove it. Set it aside.

(8) Remove the two slotted screws, located on the bottom of the ES apparatus, attaching the RF shield bracket to the base assembly. Set them aside.

(9) Remove the three hex socket screws from the lower front of the control panel assembly. Set them aside.

(10) Detach the control panel assembly from the base assembly.

(11) Disconnect P1118 from J118 on the left side of the MD/C PCB.

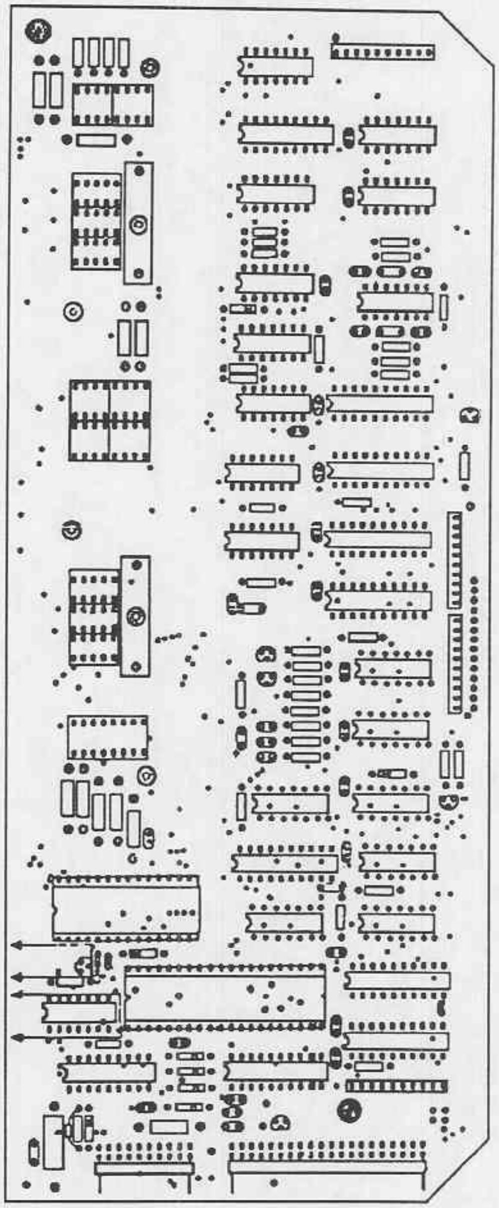


Figure 3-26. Monopolar display/control PCB.

(12) Turn the control panel assembly upside down with the RF shield facing you.

CAUTION

Rest the control panel assembly on a soft cloth to prevent marring the assembly.

(13) Remove the slotted screw and flat washer from the left side (near the bottom) of the RF shield. Set them aside.

NOTE

A white, plastic standoff will fall free. Set it aside with the screw.

(14) Remove the slotted screw from the lower right-hand corner of the RF shield while holding the shield with your other hand. Remove the shield and set it aside.

(15) Remove the hex-shaped standoff from the lower right side of the MD/C PCB. Set it aside.

(16) Remove the three slotted screws from the circuit side of the MD/C PCB. Set them aside.

(17) Lift up the MD/C PCB and disconnect P620 (keyboard ribbon cable) from J120 on the PCB. Set it aside.

b. Maintenance service. Install a replacement MD/C PCB.

c. Reassembly.

(1) Reconnect P620 (keyboard ribbon cable) to J120 on the MD/C PCB.

(2) Position the PCB into place and reinstall the three slotted screws into the circuit side of the PCB.

(3) Reinstall the hex-shaped standoff into the mounting hole in the lower right side of the MD/C PCB.

(4) Insert the longer slotted screw and flat washer through the mounting hole in the lower left side of the RF shield and then push the plastic standoff onto the screw. Then, while holding the screw and standoff with your fingers, position the screw into its mounting hole and reinstall the screw.

(5) Position the RF shield into place and reinstall the slotted screw into its mounting hole in the lower right-hand corner of the MD/C PCB.

(6) Turn the control panel assembly upright with the front control panel facing forward.

(7) Connect P1118 to J118 on the left side of the MD/C PCB.

(8) Position the control panel assembly onto the base assembly.

(9) Reinstall the three hex socket screws into the lower front of the control panel assembly to fasten it to the base assembly.

(10) Reinstall the two slotted screws through the base assembly and into the RF shield bracket.

(11) Reinstall the handle.

(12) Reinstall the slotted screw and flat washer into the left-hand handle rod.

(13) Insert the slotted screw through the crimped terminal lug of the green/yellow electrical ground wire and then the flat washer. Reinstall the screw into the right-hand handle rod.

(14) Reconnect the following electronic plugs. (Refer back to figure 3-25.)

(a) P1117 to J117

(b) P800 to J200

(c) P801 to J201

(d) P702 to J202

(e) P1103 to J203

(15) Reinstall the top cover and refasten it with the four slotted screws and lockwashers.

3-29. Bipolar display PCB (fig 3-27).

a. Disassembly.

(1) Perform the disassembly procedures contained in paragraph 3-28a.

(2) Remove the round plastic standoff from the bipolar display (BD) PCB. Set it and its slotted mounting screw aside.

(3) Remove the three slotted screws fastening the BD PCB. Set them aside.

(4) Lift up the BD PCB with one hand and disconnect P521 (keyboard ribbon cable) from J421 on the PCB with your other hand. Set it aside.

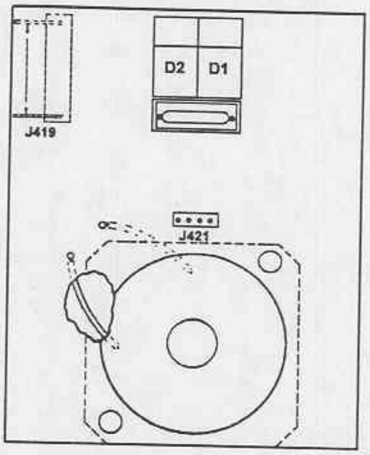


Figure 3-27. Bipolar display PCB.

b. Maintenance service. Install a replacement BD PCB.

c. Reassembly.

(1) Hold the BD PCB with one hand and reconnect P521 to J421 on the PCB with your other hand.

(2) Position the BD PCB into place and reinstall the three slotted screws to refasten it.

(3) Reinstall the round plastic standoff onto the MD PCB with its slotted screw.

(4) Complete the reassembly by following the procedures contained in paragraph 3-28c.

3-30. Monopolar or bipolar keyboard (fig 3-28).

a. Disassembly.

(1) Perform the disassembly procedures contained in paragraph 3-28a.

(2) Remove either the three slotted screws and plastic retainers fastening the monopolar keyboard or remove the two slotted screws and plastic retainers fastening the bipolar keyboard.

NOTE

Complete disassembly procedures (para 3-29a(2), (3), and (4)) if the BD PCB keyboard requires removal.

(3) Remove the keyboard, as required.

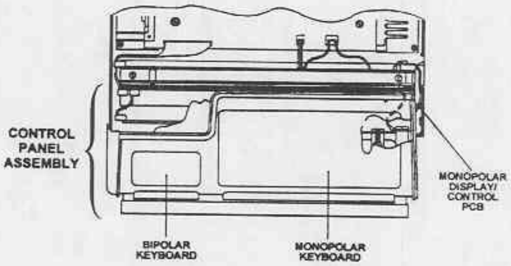


Figure 3-28. Keyboards.

b. Maintenance service.

(1) Remove the silicone sealant from the control panel assembly.

CAUTION

Solvent is not necessary. The silicone sealant will easily peel off.

(2) Place a small, uniform bead of silicone sealant around the edge of the keyboard sill on the control panel assembly.

(3) Install the replacement keyboard.

c. Reassembly.

(1) Position the replacement keyboard into place and reinstall the plastic retainers and slotted screws.

NOTE

The monopolar keyboard is fastened with three slotted screws and plastic retainers and the bipolar keyboard is fastened with two slotted screws and plastic retainers.

If the BD PCB was removed, complete the reassembly procedures contained in paragraph 3-29c(1), (2), and (3).

(2) When the silicone sealant is dry, carefully remove any excess sealant from the front of the keyboard with a razor blade.

CAUTION

Do not scrape off the silicone sealant to prevent scratching or damage to the keyboard.

3-31. Monopolar or bipolar control panel lens.

a. Disassembly.

(1) Perform the disassembly procedures contained in paragraph 3-29a.

(2) Remove any plastic lens by gently pushing outward around its edges from the back of the control panel assembly.

b. Maintenance service.

(1) Remove any residual adhesive from the control panel assembly by using a mild solvent.

(2) Peel off the adhesive backing cover and install a new lens into its frame in the control panel assembly.

c. Reassembly.

(1) Hold the BD PCB with one hand and reconnect P521 to J421 on the PCB with your other hand.

(2) Position the BD PCB into place and reinstall the three slotted screws to refasten it.

(3) Reinstall the round plastic standoff onto the MD PCB with its slotted screw.

(4) Complete the reassembly by following the procedures contained in paragraph 3-28c.

3-32. Monopolar or bipolar receptacles.

a. Disassembly.

(1) Perform the disassembly procedures contained in paragraph 3-28a.

(2) Remove the nut and lockwasher from each receptacle mount.

NOTE

The monopolar receptacle has six mounts and the bipolar receptacle has two mounts.

(3) Remove the cable ties, as necessary.

(4) Remove the applicable jack strip (receptacle mounting bracket).

(5) Remove the receptacle label as it will be damaged when removing the receptacle.

b. Maintenance service.

(1) Remove any residual adhesive from the receptacle area of the control panel assembly by using a mild solvent.

(2) Replace the receptacle label.

c. Reassembly.

(1) Position the replacement jack strip(s) into place and reinstall the nut and lockwasher for each receptacle mount.

(2) Complete the reassembly by following the procedures contained in paragraph 3-28c.

3-33. Interface PCB (fig 3-29).

a. Disassembly.

(1) Verify that the electrical power toggle switch, located on the back panel of the ES apparatus, is at the "O" symbol. Also verify that the electrical power cord is disconnected from the electrical receptacle.

(2) Remove the four slotted screws and lockwashers fastening the top cover of the ES apparatus. Set them aside.

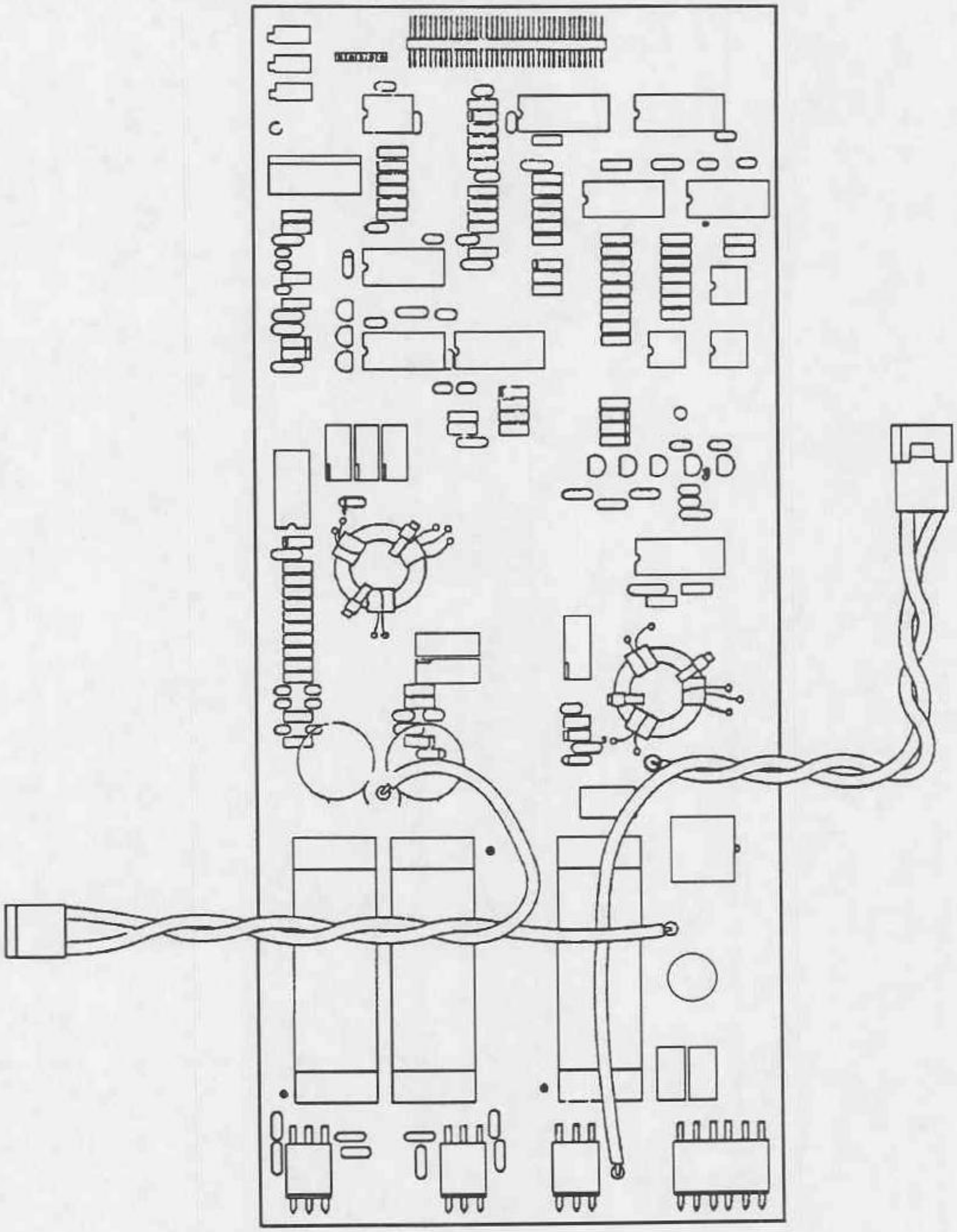


Figure 3-29. Interface PCB.

(3) Remove the top cover by gently rocking it back and forth while simultaneously pulling it upward. Set it aside.

(4) Disconnect the following electronic plugs (fig 3-30 and fig 3-31).

- (a) P800 from J200
- (b) P801 from J201
- (c) P702 from J202
- (d) P1103 from J203
- (e) P204 from J304
- (f) P205 from J305
- (g) P1106 from J206
- (h) P1108 from J208

(5) Remove the two slotted screws fastening the interface assembly to the base assembly. Set them aside.

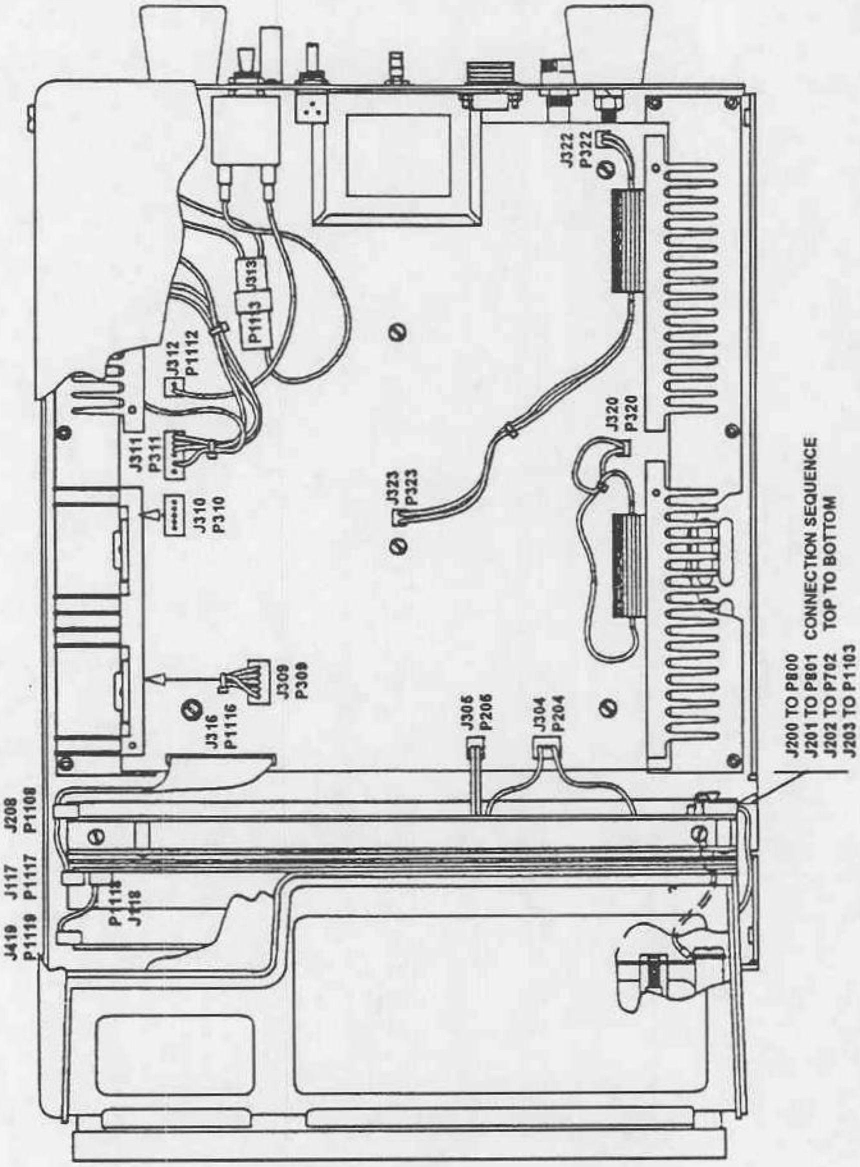

J322
P322
J313
P1113
J312
P1112
J311
P311
J310
P310
J323
P323
J320
P320
J309
P309
J316
P1116
J305
P205
J304
P204
J200 TO P800
J201 TO P801
J202 TO P702
J203 TO P1103
CONNECTION SEQUENCE
TOP TO BOTTOM
J208
P1108
J117
P1117
P1118
J118
J419
P1119

Figure 3-30. Connectors - view 1.

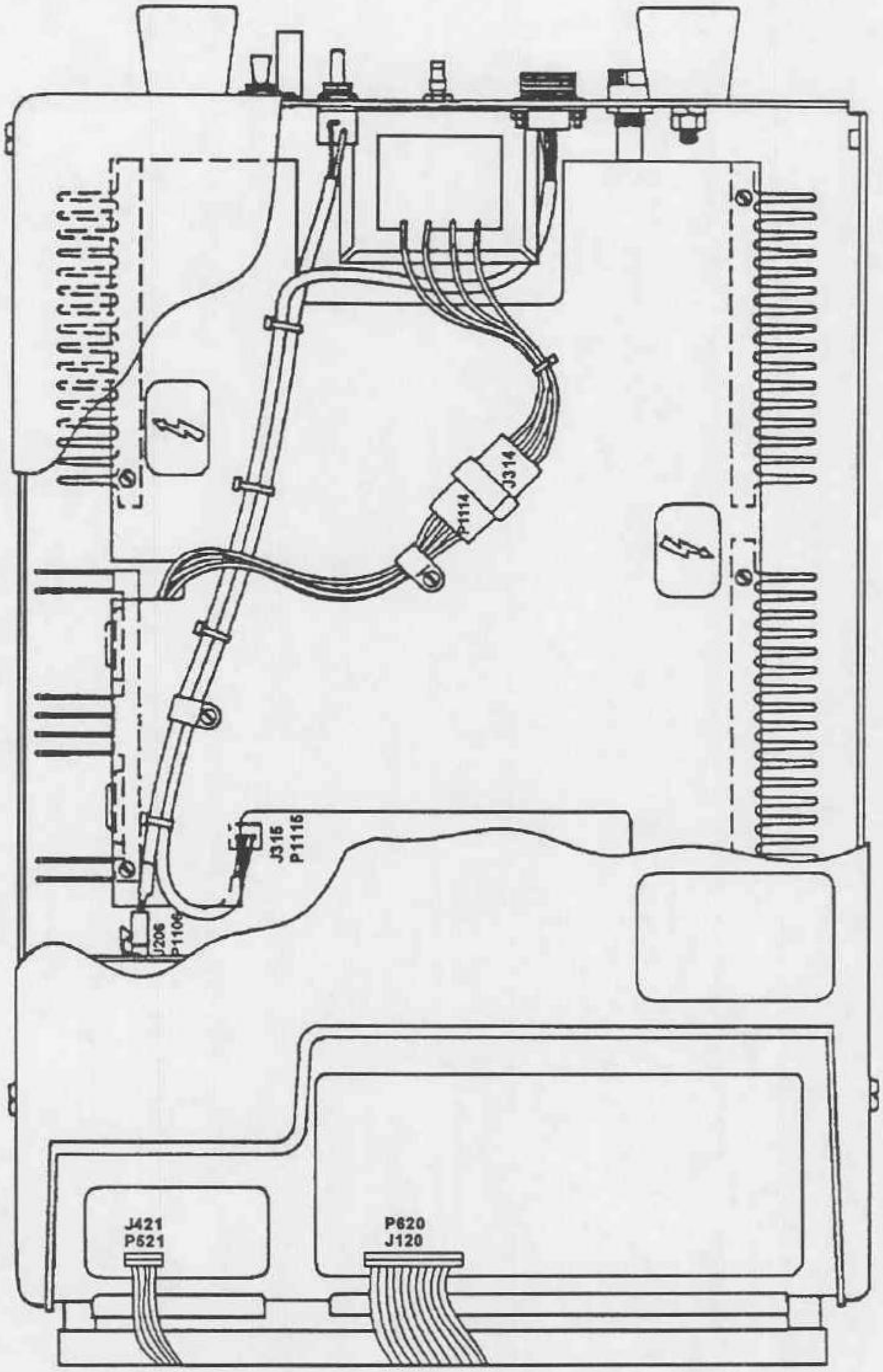

J314
P1114
J315
P1115
J206
P1106
J421
P521
P620
J120

Figure 3-31. Connectors - view 2.

NOTE

Removal of the screw from the right-hand side of the interface assembly will free the short green/yellow electrical ground wire assembly. Set them aside.

(6) Remove the interface assembly from the base assembly.

(7) Remove the five nylon slotted screws fastening the interface PCB to the interface RF shield.

b. *Maintenance service.* Replace the interface PCB.

c. *Reassembly.*

(1) Position the interface PCB and RF shield together.

(2) Reinstall the five nylon slotted screws to fasten the PCB to the RF shield.

(3) Position the interface assembly mounting holes to align with the base assembly mounting holes.

(4) Insert one of the slotted screws into the crimped terminal lug of the green/yellow electrical ground wire and then insert the screw through the mounting hole. Reinstall the nut and then reinstall the second screw and nut to fasten the interface assembly to the base assembly.

(5) Reconnect the following electronic plugs. (Refer back to figures 3-30 and 3-31.)

(a) P800 to J200
(b) P801 to J201
(c) P702 to J202
(d) P1103 to J203
(e) P204 to J304
(f) P205 to J305
(g) P1106 to J206
(h) P1108 to J208

(6) Position the top cover of the ES apparatus into place.

(7) Reinstall the four slotted screws and lockwashers to refasten the top cover to the base assembly.

3-34. Power supply/RF PCB (fig 3-32).

a. *Disassembly.*

(1) Verify that the electrical power toggle switch, located on the back panel of the ES apparatus, is at the "O" symbol. Also verify that the electrical power cord is disconnected from the electrical receptacle.

(2) Remove the four slotted screws and lockwashers fastening the top cover of the ES apparatus. Set them aside.

(3) Remove the top cover by gently rocking it back and forth while simultaneously pulling it upward. Set it aside.

(4) Remove the slotted screws fastening the two plastic cable clamps to the plastic electronics cover.

(5) Remove the four slotted screws fastening the plastic electronics cover to the heat sinks. Set them aside.

(6) Pull the plastic electronics cover out to the side below the cable assemblies. Set it aside.

(7) Disconnect the following electronic plugs. (Refer back to figures 3-30 and 3-31.)

(a) P1106 from J206
(b) P1116 from J316
(c) P204 from J304
(d) P205 from J305
(e) P1112 from J312
(f) P1113 from J313

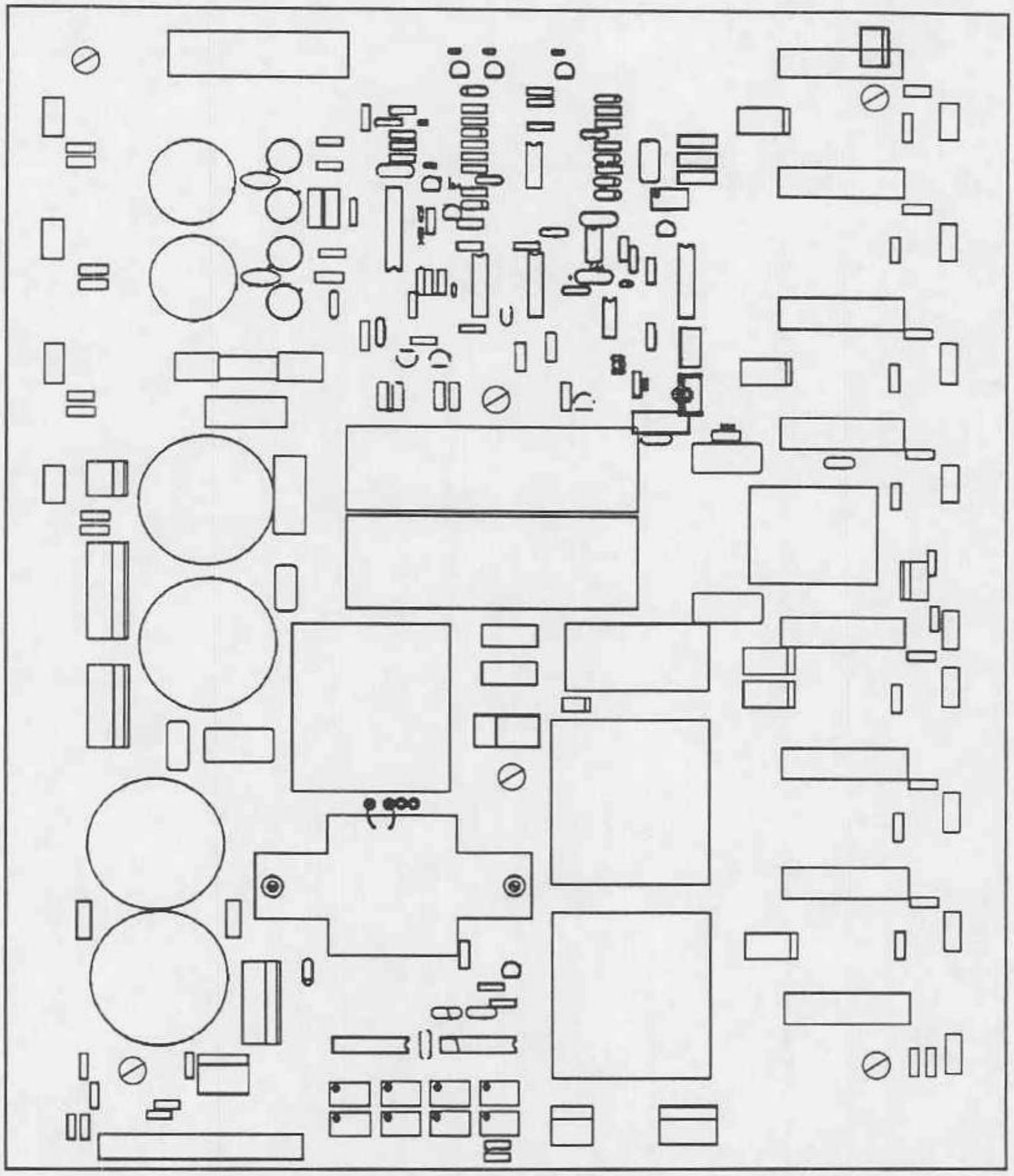


Figure 3-32. Power supply/RF PCB.

(g) P1114 from J314

(h) P1115 from J315

(i) P1108 from J208

(8) Remove the six slotted screws and five insulating plastic washers fastening the PSRF PCB to the base assembly.

NOTE

One screw uses a crimped metal lockwasher to connect the PCB to the base assembly for an electrical ground.

(9) Lift out the PSRF PCB using extreme caution.

CAUTION

The PSRF PCB contains static-sensitive devices. Use your ESD control workstation.

b. Maintenance service. Replace the PSRF PCB.

c. Reassembly.

(1) Position the PSRF into the base assembly.

(2) Reinstall the six slotted mounting screws and five insulating plastic washers to refasten the PCB.

CAUTION

Ensure that the crimped metal lockwasher is used in the left-hand front position.

(3) Reconnect the following electronic plugs (Refer back to figures 3-30 and 3-31).

(a) P1106 to J206
(b) P1116 to J316
(c) P204 to J304
(d) P205 to J305
(e) P1112 to J312
(f) P1113 to J313
(g) P1114 to J314
(h) P1115 to J315
(i) P1108 to J208

(4) Position the plastic electronics cover beneath the cable assemblies and align its mounting holes with the mounting screw holes in the heat sinks.

(5) Reinstall the four slotted screws to refasten the plastic electronics cover.

(6) Reinstall the two slotted screws to refasten the two plastic cable clamps.

(7) Position the top cover of the ES apparatus into place.

(8) Reinstall the four slotted screws and lockwashers to refasten the top cover to the base assembly.

3-35. Monopolar footswitch (fig 3-33).

a. Disassembly.

(1) Disconnect the footswitch electrical connector from its receptacle, located on the back panel of the ES apparatus. Move the footswitch to your work bench.

(2) Remove the six socket-head screws and lockwashers fastening the base housing cover. Set them aside.

(3) Remove the housing cover. Set it aside.

NOTE

The rubber gasket may either be stuck onto the housing cover or the base housing.

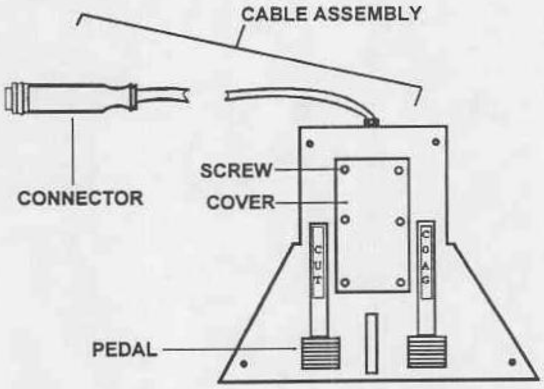


Figure 3-33. Monopolar footswitch.

b. Maintenance services.

(1) *Micro-switch replacement (fig 3-34).*

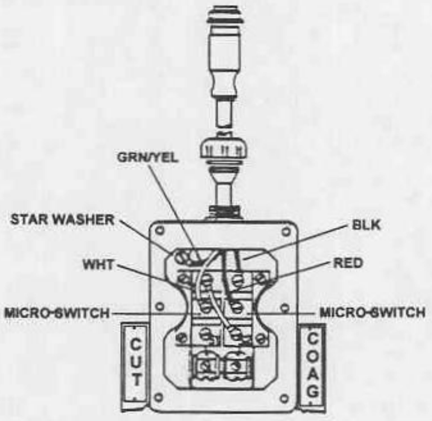

GRN/YEL
STAR WASHER
BLK
WHT
RED
MICRO-SWITCH
MICRO-SWITCH
CUT
COAG

Figure 3-34. Micro-switch replacement.

(a) Remove the five slotted screws, ring terminals with color-coded wires, and ring terminal holders from the two micro-switches. Set them aside.

(b) Remove the green, combination-head (slotted and hex) screw fastening the electrical ground terminal. Set it aside.

(c) Remove the four combination-head (slotted and Phillips) screws and lockwashers fastening the two micro-switch brackets to the footswitch base housing. Remove the brackets and set them aside with the screws and lockwashers.

(d) Test the micro-switches and replace as required. A schematic diagram of the monopolar footswitch is provided in figure 3-35.

(e) Position the micro-switches and brackets into the footswitch base housing and reinstall the four combination-head screws and lockwashers.

(f) Reinstall the electrical ground terminal by replacing the green, hex-head, slotted screw.

(g) Reinstall the five slotted screws, ring terminals with color-coded wires, ring terminal holders onto the micro-switches.

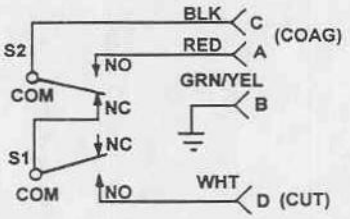

BLK
C
(COAG)
S2
RED
A
NO
GRN/YEL
COM
NC
B
NC
S1
WHT
COM
NO
D (CUT)

Figure 3-35. Monopolar footswitch schematic diagram.

(h) Perform the next maintenance service or go to the reassembly procedures.

(2) *Cable assembly replacement (fig 3-36).*

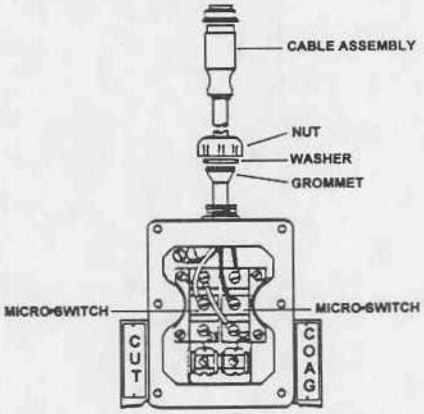

CABLE ASSEMBLY
NUT
WASHER
GROMMET
MICRO-SWITCH
MICRO-SWITCH
CUT
COAG

Figure 3-36. Cable assembly replacement.

(a) Remove the five slotted screws, ring terminals with color-coded wires, and ring terminal holders from the two micro-switches. Set them aside.

(b) Remove the green, combination-head (slotted and hex) screw fastening the electrical ground terminal. Set it aside.

(c) Loosen the fluted strain relief nut and slide it up the footswitch cable.

(d) Pull the cable through the strain relief assembly.

(e) Slide the rubber strain relief grommet and the fluted strain relief nut and washer from the unserviceable cable.

(f) Slide the fluted strain relief nut and then the rubber strain relief nut onto the replacement cable.

(g) Push and pull the cable wires through the strain relief housing.

(h) Reinstall the electrical ground terminal by replacing the green, combination-head (slotted and hex) screw.

(i) Reinstall the five slotted screws, ring terminals with color-coded wires, and ring terminal holders onto the micro-switches.

(j) Perform the next maintenance service or go to the reassembly procedures.

(3) *Pedal movement adjustment (fig 3-37).*

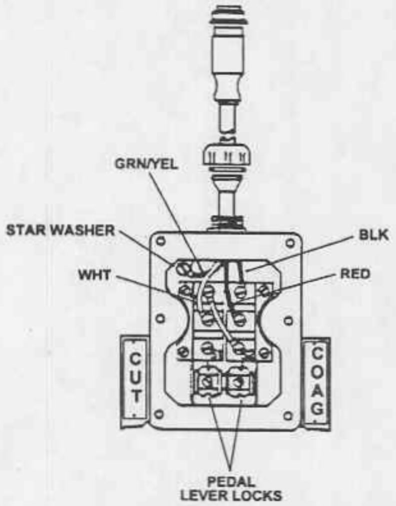


Figure 3-37. Pedal movement adjustment.

(a) Remove the five slotted screws, ring terminals with color-coded wires, and ring terminal holders from the two micro-switches. Set them aside.

(b) Remove the green, combination-head (slotted and hex) screw fastening the electrical ground terminal. Set it aside.

(c) Remove the four combination-head (slotted and Phillips) screws and lockwashers fastening the two micro-switch brackets to the footswitch base housing. Remove the brackets and set them aside with the screws and lockwashers.

(d) Lift out the micro-switches.

(e) Loosen the desired slotted screw locking the pedal to micro-switch lever and reposition the lever. Tighten the screw.

(f) Position the micro-switches and brackets into the footswitch base housing and reinstall the four combination-head screws and lockwashers.

(g) Test the monopolar footswitch "CUT" pedal by lightly touching the pedal while moving the "COAG" pedal up and down three times. Test the "COAG" pedal by lightly touching the pedal while moving the "CUT" pedal up and down three times. In both tests the pedal being cycled up and down should move freely without binding or hesitation and its movement should not be detected in the other pedal.

NOTE

Additional adjustment necessitates a repeat of preceding steps (c), (d), (e), and (f).

(h) Reinstall the electrical ground terminal by replacing the green, combination-head (slotted and hex) screw.

(i) Reinstall the five slotted screws, ring terminals with color-coded wires, and ring terminal holders onto the micro-switches.

c. Reassembly.

(1) Position the rubber gasket over the housing cover mounting holes.

(2) Position the housing cover over the rubber gasket and hold it in place.

(3) Reinstall the six socket-head screws and lockwashers to refasten the housing cover to the monopolar footswitch base housing.

(4) Reconnect the footswitch electrical connector to its mating receptacle, located on the back panel of the ES apparatus.

3-36. Bipolar footswitch (fig 3-38).

a. Disassembly.

(1) Disconnect the footswitch electrical connector from its receptacle, located on the back panel of the ES apparatus. Move the footswitch to your work bench.

(2) Remove the two Phillips screws from the bottom cover of the footswitch. Remove the cover and set it aside with the screws.

b. Maintenance services.

(1) *Switch replacement.*

(a) Remove the two combination-head (slotted and Phillips) screws and lockwashers located astride the pedal actuator coil spring to free it from the housing assembly. Set them aside.

(b) Remove the two slotted screws and lockwashers from the micro-switch fastening it to the micro-switch bracket and assembly. Set the bracket assembly, screws, and lockwashers aside.

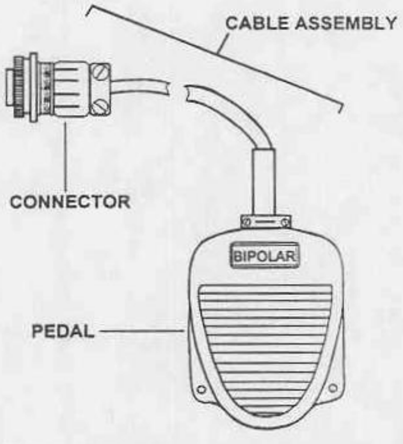


Figure 3-38. Bipolar footswitch.

NOTE

Two strips of yellow micro-switch electrical insulation materiel will also be freed when the micro-switch bracket and assembly are disconnected.

(c) Remove the two brass slotted screws fastening the two electrical wire terminals to the micro-switch. Set them aside.

(d) Test the micro-switch for continuity using a multimeter and replace the micro-switch as required. A schematic diagram of the bipolar footswitch is provided in figure 3-39.

(e) Reinstall the two brass slotted screws to refasten the two electrical wire terminals to the micro-switch. Check for the correct connection of the wires. (Refer back to figure 3-37.)

(f) Position the bracket, insulation strip, micro-switch, insulating strip, and bracket in this order. Align the mounting holes and reinstall the two slotted screws and lockwashers.

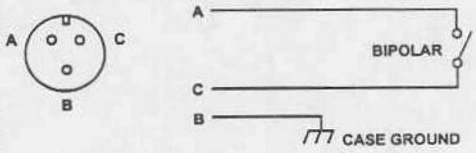


Figure 3-39. Bipolar footswitch schematic diagram.

(g) Position the micro-switch bracket assembly into its mounting location in the footswitch housing assembly and reinstall the two combination-head (slotted and Phillips) screws and lockwashers.

(h) Perform the next maintenance service or go to the reassembly procedures.

(2) *Cable assembly replacement.*

(a) Remove the two combination-head (slotted and Phillips) screws and lockwashers located astride the pedal actuator coil spring to free it from the housing assembly. Set them aside.

(b) Remove the two brass slotted screws fastening the two electrical wire terminals to the micro-switch. Set them aside.

(c) Remove the slotted screw and ring terminal holder fastening the ground wire terminal to the housing assembly. Set them aside.

(d) Remove the two slotted screws from the cable clamp assembly. Remove the clamp bracket and set it and the screws aside.

(e) Pull the electrical cable and cable protector sleeve from the clamp assembly. Remove the cable protector sleeve from the cable. Set the sleeve aside.

(f) Replace the cable.

(g) Reinstall the cable protector sleeve onto the replacement electrical cable.

(h) Push the three electrical wires of the cable assembly through the cable clamp assembly.

(i) Reinstall the green grounding wire by replacing the ring terminal holder and slotted screw.

(j) Reinstall the two brass slotted screws fastening the two electrical wire terminals. Check for the correct connection of the wires. (Refer back to figure 3-37.)

(k) Position the electrical cable with the cable protector sleeve for a slight wiring slack inside the footswitch housing. Then position the clamp bracket and use the two slotted screws to refasten it.

c. Reassembly.

(1) Position the footswitch bottom cover onto the footswitch and reinstall the two Phillips screws to refasten it.

(2) Reconnect the footswitch electrical connector to its mating receptacle, located on the back panel of the ES apparatus.

Section IX. CALIBRATION INSTRUCTIONS

3-37. General.

a. This section of the manual contains eight specific calibration requirements for the ES apparatus. Review the requirements and proceed directly to your specific requirement(s).

b. Access the calibration test points and controls by completing the following disassembly procedures.

(1) Verify that the electrical power toggle switch, located on the back panel of the ES apparatus, is at the "O" symbol. Also verify that the electrical power cord is disconnected from the electrical receptacle.

(2) Remove the four slotted screws and lockwashers fastening the top cover of the ES apparatus. Set them aside.

(3) Remove the top cover by gently rocking it back and forth while simultaneously pulling it upward. Set it aside.

(4) Remove the slotted screws fastening the two plastic cable clamps to the plastic electronics cover. Set them aside.

(5) Remove the four slotted screws fastening the plastic electronics cover to the heat sinks. Set them aside.

(6) Pull the plastic electronics cover toward the left side and free it from the cables above it. Set it aside.

(7) Connect the electrical power cord to an electrical receptacle.

(8) Turn the electrical power on by pulling the toggle switch, located on the back panel of the ES apparatus, up to the "|" symbol.

CAUTION

High voltage is now present on multiple components.

NOTE

The ES apparatus will automatically undergo an internal self-test process.

(9) Observe the control panel. The following control panel actions will automatically occur (fig 3-40 and fig 3-41).

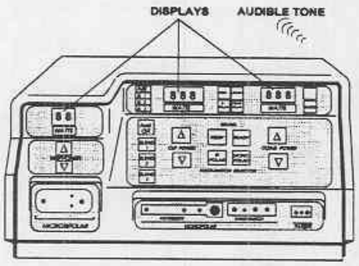


Figure 3-40. Self-test displays.

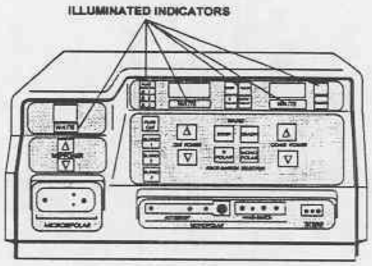


Figure 3-41. Self-test illuminated indicators.

(a) an audible tone momentarily sounds,

(b) the 3 digital displays show "8"s,

(c) all 13 indicators illuminate.

(10) Continue to observe the control panel. The following control panel actions will automatically occur (fig 3-42).

(a) The three digital displays show "- - -."

(b) The yellow "STDBY" indicator illuminates.

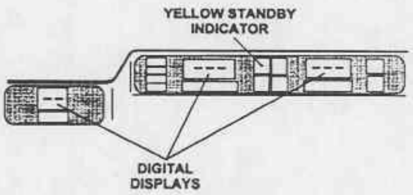


Figure 3-42. Standby mode.

c. Upon completion of either a single or multiple calibration requirements, perform the following reassembly procedures.

(1) Push the electrical power toggle switch downward to the "O" symbol if further use is not required.

(2) Position the plastic electronics cover beneath the cable assemblies and align its mounting holes with the mounting screw holes in the heat sinks.

(3) Reinstall the four slotted screws to refasten the cover.

(4) Reinstall the two slotted screws to refasten the two plastic cable clamps.

(5) Position the top cover of the ES apparatus into place.

(6) Reinstall the four slotted screws and lockwashers to refasten the top cover to the base assembly.

3-38. Calibration requirements and procedures.

NOTE

Use a non-metallic alignment tool to adjust electronic components.

a. +12 VDC supply.

(1) Access the calibration test points and controls by completing the procedures contained in paragraph 3-37b.

(2) Connect a digital multimeter between pins 1 or 2 and 5 or 6 on P1116/J316. (Refer back to figure 3-30.)

(3) Observe the voltage. It should be +12 VDC ±0.2 volts.

NOTE

No +12 VDC adjustment is available. Component replacement is necessary if the voltage is out of tolerance.

(4) Proceed to the next calibration requirement or reassemble the ES apparatus by following the procedures contained in paragraph 3-37c.

b. +5 VDC supply.

(1) Access the calibration test points and controls by completing the procedures contained in paragraph 3-37b.

NOTE

If this is a follow-on requirement, access to the calibration test points and controls has been completed.

(2) Connect a digital multimeter between pins 1 or 2 and 3 or 4 on P1116/J316. (Refer back to figure 3-30.)

(3) Observe the voltage which should be +5 VDC ±0.25 volts.

NOTE

No +5 VDC adjustment is available. Component replacement is necessary if the voltage is out of tolerance.

(4) Proceed to the next calibration requirement or reassemble the ES apparatus by following the procedures contained in paragraph 3-37c.

c. -5 VDC supply.

(1) Access the calibration test points and controls by completing the procedures contained in paragraph 3-37b.

NOTE

If this is a follow-on requirement, access to the calibration test points and controls has been completed.

(2) Connect a digital multimeter between pins 1 or 2 and 7 on P1116/J316. (Refer back to figure 3-30.)

(3) Observe the voltage which should be -5 VDC ±0.2 volts.

NOTE

No -5 VDC adjustment is available. Component replacement is necessary if the voltage is out of tolerance.

(4) Proceed to the next calibration requirement or reassemble the ES apparatus by following the procedures contained in paragraph 3-37c.

d. High voltage clamp.

CAUTION

Multiple components float (not referenced to electrical ground) at potentially harmful voltage potentials. Use special precaution.

(1) Access the calibration test points and controls by completing the procedures contained in paragraph 3-37b.

NOTE

If this is a follow-on requirement, access to the calibration test points and controls has been completed.

(2) Connect a wattmeter with a 300-ohm load from the active pin of the "ACCESSORY" receptacle to the "PATIENT" receptacle (fig 3-43).

(3) Depress the white "READY" keyboard switch.

(4) Observe the control panel. The following control panel actions will automatically occur.

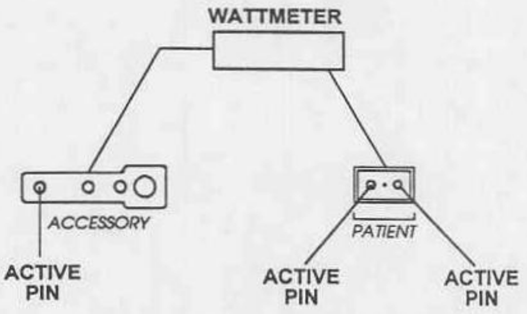


Figure 3-43. Receptacle test connections.

NOTE

Steps (a) and (b) below are valid only when the patient return electrode is disconnected from the "PATIENT" receptacle.

(a) The alarm tone sounds twice.

(b) The red alarm indicator illuminates.

(c) The green "READY" indicator illuminates.

(d) The three digital displays show a "1."

(e) The yellow "MONOPOLAR" indicator illuminates.

(f) The yellow "PURE" indicator illuminates.

NOTE

The monopolar footswitch mode is required.

(5) Set the "COAG POWER" to 30 watts by depressing the up (Δ) keyboard switch until 30 shows in the right-hand digital display.

(6) Depress the "COAG" pedal on the monopolar footswitch.

(7) Observe the wattmeter which should be 30 ±5 watts. Release the "COAG" pedal.

(8) Set the "COAG POWER" to 1 watt by depressing the down (∇) keyboard switch until 1 shows in the right-hand digital display.

(9) Connect an oscilloscope with a 100X probe between the anode of diode CR3 and electrical ground on the PSRF PCB (fig 3-44).

(10) Depress the "COAG" pedal momentarily on the monopolar footswitch until you observe the peak positive voltage.

(11) Slowly increase the "COAG POWER" by depressing the up (Δ) keyboard switch, depress the "COAG" pedal momentarily, and repeat the steps until you observe the peak positive voltage.

(12) Adjust resistor R29 on the PSRF PCB so that the maximum peak voltage is +400 volts.

WARNING

Do not allow the peak voltage to exceed +400 volts while making this calibration to preclude damage to the electronic components.

(13) Place a small dab of sealing compound on the resistor adjustment screw to lock it at the new setting.

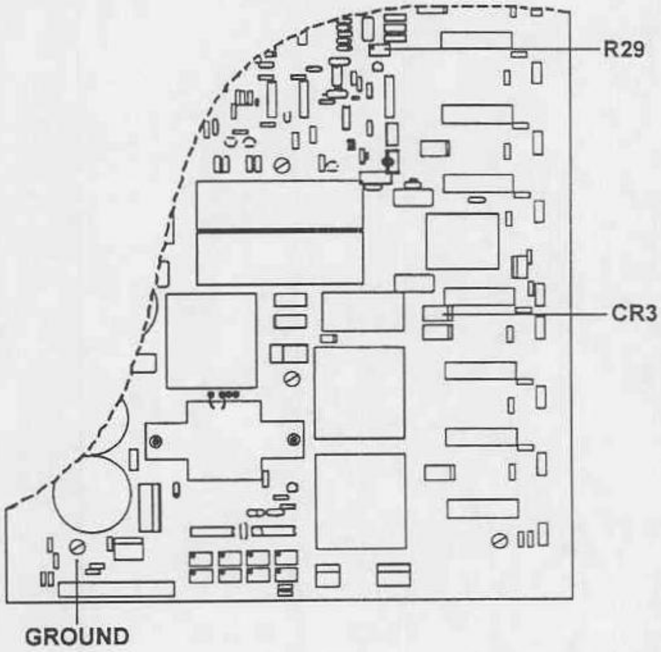


Figure 3-44. High voltage clamp adjustment.

(14) Depress the white "STDBY" keyboard switch to return the ES apparatus to the standby mode.

(15) Remove the wattmeter.

(16) Disconnect the monopolar footswitch.

(17) Proceed to the next calibration requirement or reassemble the ES apparatus by following the procedures contained in paragraph 3-37c.

e. CUT power.

(1) Access the calibration test points and controls by completing the procedures contained in paragraph 3-37b.

NOTE

If this is a follow-on requirement, access to the calibration test points and controls has been completed.

(2) Connect a wattmeter with a 300-ohm load from the active pin of the "ACCESSORY" receptacle to the "PATIENT" receptacle. (Refer back to figure 3-43.)

(3) Depress the white "READY" keyboard switch.

(4) Observe the control panel. The following control panel actions will automatically occur.

NOTE

Steps (a) and (b) below are valid only when the patient return electrode is disconnected from the "PATIENT" receptacle.

(a) The alarm tone sounds twice.

(b) The red alarm indicator illuminates.

(c) The green "READY" indicator illuminates.

(d) The three digital displays show a "1."

(e) The yellow "MONOPOLAR" indicator illuminates.

(f) The yellow "PURE" indicator illuminates.

NOTE

The monopolar footswitch mode is required.

(5) Set "CUT POWER" to 300 watts by depressing the up (Δ) keyboard switch until 300 shows in the center digital display.

(6) Adjust resistor R93 to approximately the midpoint and turn resistor R89 fully clockwise (fig 3-45).

(7) Depress the "CUT" pedal on the monopolar footswitch.

(8) Observe the wattmeter and adjust resistor R93 until the wattmeter indicates 300. Release the "CUT" pedal.

(9) Change the wattmeter load to 100 ohms.

(10) Turn resistor R89 counterclockwise to its midpoint.

(11) Depress the "CUT" pedal on the monopolar footswitch.

(12) Observe the wattmeter and adjust resistor R89 until the wattmeter indicates 260 ±40. Release the pedal.

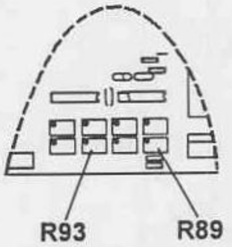


Figure 3-45. CUT power calibration.

(13) Depress the white "STDBY" keyboard switch to return the ES apparatus to the standby mode.

(14) Place a small dab of sealing compound on the resistor adjustment screws to lock them at their new settings.

(15) Remove the wattmeter.

(16) Proceed to the next cabibration requirement or reassembly the ES apparatus by following the procedures contained in paragraph 3-37c.

f. BLEND 2 power.

(1) Access the calibration test points and controls by completing the procedures contained in paragraph 3-37b.

NOTE

If this is a follow-on requirement, access to the calibration test points and controls has been completed.

(2) Connect a wattmeter with a 300-ohm load from the active pin of the "ACCESSORY" receptacle to the "PATIENT" receptacle. (Refer back to figure 3-43.)

(3) Depress the white "READY" keyboard switch.

(4) Observe the control panel. The following control panel actions will automatically occur.

NOTE

Steps (a) and (b) below are valid only when the patient return electrode is disconnected from the "PATIENT" receptacle.

(a) The alarm tone sounds twice.

(b) The red alarm indicator illuminates.

(c) The green "READY" indicator illuminates.

(d) The three digital displays show a "1."

(e) The yellow "MONOPOLAR" indicator illuminates.

(f) The yellow "PURE" indicator illuminates.

NOTE

The monopolar footswitch mode is required.

(5) Depress the yellow "BLEND 2" keyboard switch.

(6) Set "CUT POWER" to 200 watts by depressing the up (Δ) keyboard switch until 200 shows in the center digital display.

(7) Adjust resistor R94 to approximately midpoint and turn resistor R90 fully clockwise (fig 3-46).

(8) Depress the "CUT" pedal on the monopolar footswitch.

(9) Observe the wattmeter and adjust resistor R94 until the wattmeter indicates 200. Release the "CUT" pedal.

(10) Change the wattmeter load to 100 ohms.

(11) Turn resistor R89 counterclockwise to its midpoint.

(12) Depress the "CUT" pedal on the monopolar footswitch.

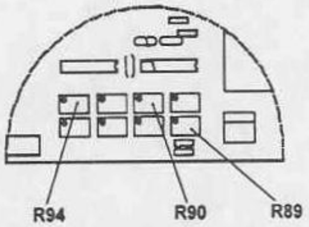


Figure 3-46. BLEND 2 power calibration.

(13) Observe the wattmeter and adjust resistor R90 until the wattmeter indicates 150 ±50. Release the pedal.

(14) Change the wattmeter load to 300 ohms.

(15) Depress the yellow "BLEND 1" keyboard switch.

(16) Depress the "CUT" pedal on the monopolar footswitch momentarily and observe the wattmeter which should indicate 200. Record the watts, if out of tolerance.

(17) Depress the yellow "BLEND 3" keyboard switch.

(18) Depress the "CUT" pedal on the monopolar footswitch momentarily and observe the wattmeter which should indicate 200. Record the watts, if out of tolerance.

(19) Determine the deviation from specifications for BLEND 1 and BLEND 3 modes. If a deviation exists—

(a) repeat procedures (5) through 13) above and adjust resistors R90 and R94 very closely, or

(b) repeat procedures (14) through (18) above.

(20) Depress the white "STDBY" keyboard switch to return the ES apparatus to the standby mode.

(21) Place a small dab of sealing compound on the resistor adjustment screws to lock them at their new settings.

(22) Remove the wattmeter.

(23) Proceed to the next calibration requirement or reassemble the ES apparatus by following the procedures contained in paragraph 3-37*c*.

g. COAG power.

(1) Access the calibration test points and controls by completing the procedures contained in paragraph 3-37b.

NOTE

If this is a follow-on requirement, access to the calibration test points and controls has been completed.

(2) Connect a wattmeter with a 300-ohm load from the active pin of the "ACCESSORY" receptacle to the "PATIENT" receptacle. (Refer back to figure 3-43.)

(3) Depress the white "READY" keyboard switch.

(4) Observe the control panel. The following control panel will automatically occur.

(a) The alarm tone sounds twice.

(b) The red alarm indicator illuminates.

(c) The green "READY" indicator illuminates.

(d) The three digital displays show a "1."

(e) The yellow "MONOPOLAR" indicator illuminates.

(f) The "PURE" indicator illuminates.

NOTE

The monopolar footswitch mode is required.

(5) Set "COAG POWER" to 120 watts by depressing the up (Δ) keyboard switch until 120 shows in the right-hand digital display.

(6) Adjust resistor R95 to approximately midpoint and turn resistor R91 fully clockwise (fig 3-47).

(7) Depress the "COAG" pedal on the monopolar footswitch.

(8) Observe the wattmeter and adjust resistor R95 until the wattmeter indicates 120. Release the "COAG" pedal.

(9) Change the wattmeter load to 100 ohms.

(10) Turn resistor R91 counterclockwise to its midpoint.

(11) Depress the "COAG" pedal on the monopolar footswitch.

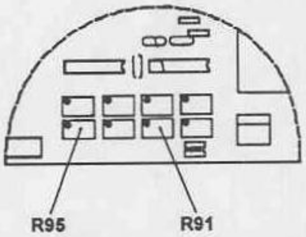


Figure 3-47. COAG power calibration.

(12) Observe the wattmeter and adjust resistor R91 until the wattmeter indicates 100 ±20. Release the pedal.

(13) Depress the white "STDBY" keyboard switch to return the ES apparatus to the standby mode.

(14) Place a small dab of sealing compound on the resistor adjustment screws to lock them at their new settings.

(15) Remove the wattmeter.

(16) Proceed to the next calibration requirement or reassemble the ES apparatus by following the procedures contained in paragraph 3-37c.

h. Microbipolar output.

(1) Access the calibration test points and controls by completing the procedures contained in paragraph 3-37b.

NOTE

If this is a follow-on requirement, access to the calibration test points and controls has been completed.

(2) Connect a wattmeter with a 100-ohm load across the active pins of the "MICROBIPOLAR" receptacle (fig 3-48).

(3) Depress the white "READY" keyboard switch.

(4) Observe the control panel. The following control panel actions will automatically occur.

(a) The alarm tone sounds twice.

(b) The red alarm indicator illuminates.

(c) The green "READY" indicator illuminates.

(d) The three digital displays show a "1."

(e) The yellow "MONOPOLAR" indicator illuminates.

(f) The "PURE" indicator illuminates.

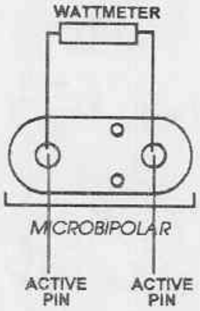


Figure 3-48. Test circuit.

(5) Depress the white "BIPOLAR" keyboard switch.

NOTE

The bipolar mode is required.

(6) Set the "MBP POWER" to 70 watts by depressing the up (Δ) keyboard switch until 70 shows in the left-hand digital display.

(7) Activate a bipolar accessory switch (handswitching forceps) and observe the wattmeter while adjusting resistor R92 (fig 3-49) for 70 watts. Release the accessory switch.

(8) Activate the bipolar accessory switch again and observe the wattmeter while adjusting resistor R88 counterclockwise until it affects the wattmeter indication. Release the accessory switch.

(9) Turn the resistor R88 adjusting screw one full turn clockwise.

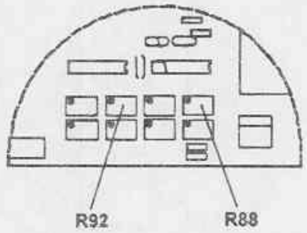


Figure 3-49. MBP output calibration.

(10) Depress the white "STDBY" keyboard switch to return the ES apparatus to the standby mode.

(11) Place a small dab of sealing compound on the resistor adjustment screws to lock them at their new settings.

(12) Remove the wattmeter.

(13) Proceed to the next calibration requirement or reassemble the ES apparatus by following the procedures contained in paragraph 3-37c.

Section X. STORING AND SHIPPING PROCEDURES

3-39. General.

a. This section contains the procedures for preparing the ES apparatus for storing and shipping. These procedures will vary significantly for the mobile cart, accessories, and electrodes depending upon ES apparatus location.

b. A soft, canvas case is provided for unit-level storage of the mobile cart to both minimize weight and provide protection. The cart shelves may be used to store the accessories, electrodes, and supplies or another chest could be used depending upon the desire of each unit.

3-40. Preparation for storing.

a. Shut down the ES apparatus, if it has been in use, as follows:

(1) Depress the white "STDBY" keyboard switch to return the ES apparatus to the standby mode.

(2) Turn the electrical power off by pushing the toggle switch, located on the back panel of the ES apparatus, downward to the "O" symbol.

b. Disconnect the accessories. Set them aside.

c. Disconnect the electrical power cord from the electrical wall receptacle.

d. Remove the two slotted screws and bracket fastening the electrical power cord connector to the electrical power input receptacle, located on the back panel of the ES apparatus. Pull out the connector. Reinstall the bracket and two slotted screws.

e. Coil the electrical power cord and place it into its storage location within the chest.

f. Disconnect the footswitch(es) from the back panel of the ES apparatus.

g. Coil the electrical power cables of the footswitches and place the footswitches into the chest.

NOTE

The monopolar footswitch is stored in the center bottom compartment below the hinged compartment lid.

h. Clean the ES apparatus, the mobile cart, and footswitches by following the procedures contained in paragraphs 2-23 through 2-25.

i. Unfasten the ES apparatus from the mobile cart by:

(1) Removing the two nylon finger screws from the underside of the adjustable mobile cart top. Store the two screws and the two fender washers for future use.

(2) Lifting the ES apparatus from the mobile cart and set it down on its back feet.

(3) Locating the two rubber feet with integral screws removed during the assembly process, insert the screws through the rubber grommets (setting on top of the mobile cart), and install them onto the bottom of the ES apparatus.

j. Place the ES apparatus into the chest.

k. Place the manuals into the chest.

l. Close the hinged lid and lock the five twist-lock fasteners.

m. Clean all accessories and electrodes by following the procedures contained in chapter 2, section VII.

n. Pack the accessories, cable assemblies, electrodes, and supplies. Use the blue, plastic tip protectors, clear plastic storage tubes, etc., to protect the items. Set them aside.

o. Pack the mobile cart as follows:

(1) Lay the canvas case on the floor with the inside of the canvas case facing up.

(2) Place the mobile cart on its left side into the case with the casters toward the bottom of the case.

(3) Place the accessories, electrodes, and supplies into the mobile cart.

(4) Lift and fasten each side of the case to the top using the hook-and-loop straps.

NOTE

The two side and top flap straps should be aligned.

(5) Lift the end flap and fasten it on three sides using the hook-and-loop straps.

NOTE

The two white arrows on the end of the canvas case should be pointing up.
The canvas case can be moved using the long looped carrying straps.

3-41. Preparation for shipping.

a. The chest, with the ES apparatus packed inside, is suitable for storing or shipping.

b. The mobile cart packed in the canvas case must be packed into a cardboard carton for long-term storage and crated for shipping. Notify your unit transportation point.

CHAPTER 4

DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE

Section I. GENERAL INFORMATION

4-1. Overview.

This chapter provides for maintenance that is beyond the capability, capacity, and authorization for unit level maintenance personnel. The procedures in this chapter will not be attempted at the unit level.

4-2. Tools and test equipment.

Common tools and test equipment required for support maintenance of the equipment are listed in appendix B, section III. Refer to your unit's MTOE or installation table of distribution and allowances (TDA) for authorized items.

4-3. Components of end item and basic issue items.

Components of end item and basic issue items are listed in appendix C, sections II and III.

4-4. Expendable supplies.

Expendable and durable supplies and materials for support maintenance are listed in appendix D, section II.

4-5. Repair parts.

Repair parts required for support maintenance are listed in appendix E, section II.

4-6. Special tools.

Special tools required for support maintenance are listed in appendix E, section III.

Section II. CIRCUIT DESCRIPTIONS

4-7. General.

a. This section will provide a basic operational description of the ES apparatus using a block diagram and a circuit description of each PCB.

b. The block diagram (fig 4-1) does not conform exactly to the PCB circuitry and is intended only to provide a basic operational description of the ES apparatus.

c. This section also contains the ES apparatus interconnection diagram (fig 4-2), illustrations of the PCBs, and wiring diagrams or schematics of the PCBs.

4-8. ES apparatus operational description.

a. Electrical power flows through the electrical power cord assembly, through the combination power switch/circuit breaker to two main areas.

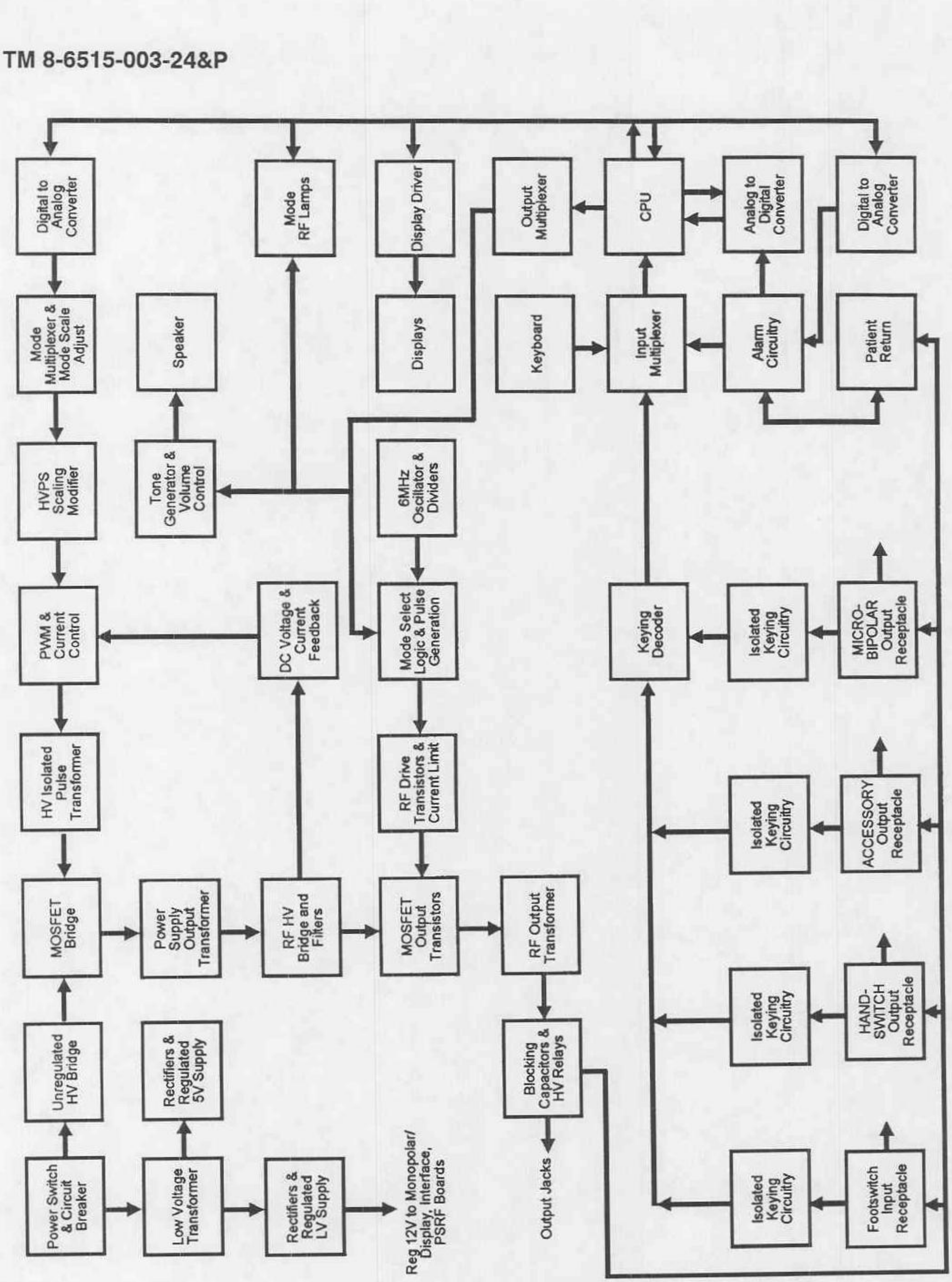

Power Switch & Circuit Breaker
Unregulated HV Bridge
MOSFET Bridge
HV Isolated Pulse Transformer
PWM & Current Control
HVPS Scaling Modifier
Mode Multiplexer & Mode Scale Adjust
Digital to Analog Converter
Low Voltage Transformer
Rectifiers & Regulated 5V Supply
Power Supply Output Transformer
Tone Generator & Volume Control
Speaker
Rectifiers & Regulated LV Supply
RF HV Bridge and Filters
DC Voltage & Current Feedback
Mode RF Lamps
Reg 12V to Monopolar/ Display, Interface, PSRF Boards
MOSFET Output Transistors
RF Drive Transistors & Current Limit
Mode Select Logic & Pulse Generation
6MHz Oscillator & Dividers
Displays
Display Driver
Output Jacks
Blocking Capacitors & HV Relays
RF Output Transformer
Keyboard
Output Multiplexer
Keying Decoder
Input Multiplexer
CPU
Isolated Keying Circuitry
Isolated Keying Circuitry
Isolated Keying Circuitry
Isolated Keying Circuitry
Alarm Circuitry
Analog to Digital Converter
Footswitch Input Receptacle
HAND-SWITCH Output Receptacle
ACCESSORY Output Receptacle
MICRO-BIPOLAR Output Receptacle
Patient Return
Digital to Analog Converter

Figure 4-1. Block diagram.

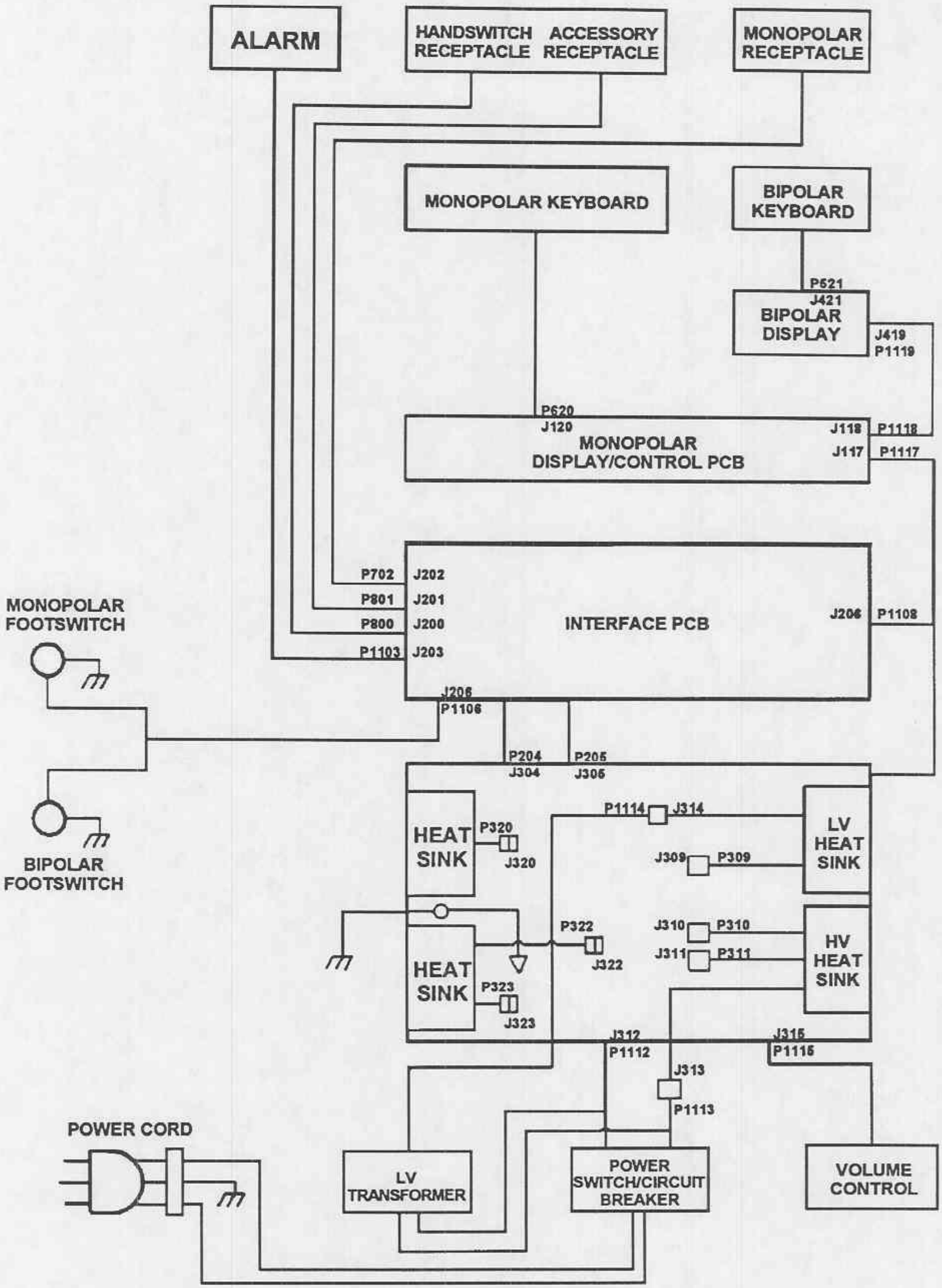

ALARM
HANDSWITCH RECEPTACLE
ACCESSORY RECEPTACLE
MONOPOLAR RECEPTACLE
MONOPOLAR KEYBOARD
BIPOLAR KEYBOARD
P521
J421
BIPOLAR DISPLAY
J419
P1119
P620
J120
MONOPOLAR DISPLAY/CONTROL PCB
J118
P1118
J117
P1117
P702
J202
P801
J201
P800
J200
P1103
J203
INTERFACE PCB
J208
P1108
J206
P1106
MONOPOLAR FOOTSWITCH
BIPOLAR FOOTSWITCH
P204
J304
P205
J305
HEAT SINK
P320
J320
P1114
J314
LV HEAT SINK
J309
P309
HEAT SINK
P322
J322
P323
J323
J310
P310
J311
P311
HV HEAT SINK
J312
P1112
J315
P1115
J313
P1113
POWER CORD
LV TRANSFORMER
POWER SWITCH/CIRCUIT BREAKER
VOLUME CONTROL

Figure 4-2. ES apparatus interconnection diagram.

(1) The first area is the low voltage transformer which has two secondary windings. One of these windings feeds a full-wave bridge rectifier with filtered output which is supplied to the +12 VDC regulator. The second winding is rectified, filtered, and supplied to the +5 VDC regulator. Both of these regulators (+12 VDC and +5 VDC) are linear pass devices physically located on the low voltage heat sink assembly. The regulated voltages are routed to all PCBs through ribbon cables to power all low voltage devices.

(2) The second area is the high voltage (HV) bridge rectifier and the voltage doubler. This unregulated HVDC is used as the supply for the variable HV switch mode power supply and measures approximately +310 VDC of nominal input power.

b. The regulated HV supply consists of seven major parts. The critical section of the HV supply is an integrated circuit (IC) referred to as a pulse width modulator (PWM). The PWM is designed to operate at 80 kHz. A control voltage proportional to the desired output wattage of the ES apparatus is supplied to the PWM. The PWM is isolated from the AC electrical supply and power devices by a pair of pulse transformers. The metal oxide semi-conductor field-effect transistor (MOSFET) bridge rectifier consists of four power MOSFETs coupled with the power supply output transformer. The output of this transformer is rectified, filtered, and used to drive the RF output stage. A portion of this voltage is also fed back to the PWM and compared to the control voltage. Any error between the control voltage and the feedback voltage will cause a proportional change in pulse width by the PWM. In the event of high current, the output of the PWM is interrupted which limits the maximum output current.

c. The ES apparatus can be activated by either monopolar or bipolar footswitches or by using a handswitching accessory in one of the three receptacles. All of the signals for activating the ES apparatus are isolated by transformer coupled DC to DC converters and optoisolators. The activating signals from the optoisolators are decoded by a custom decoder and fed to one of the microprocessor's (CPU's) input multiplexers where final action to determine exactly what mode and which output is to be enabled.

d. Mode selection and wattage are set through the monopolar and bipolar keyboards. When a keyboard switch is depressed, signals are sent to the input multiplexer, then to the CPU. The signals, decoded by the CPU, then address the output multiplexer which in turn activates the appropriate mode indicators and digital displays through the display drivers.

e. The RF power of the ES apparatus is set by the CPU which determines the wattage set point and generates a DC control voltage through the digital to analog converter. This voltage is fed to the mode multiplexer and scale adjust circuitry where the control voltage is calibrated for each individual mode of operation. The scaling modifier serves to reduce open circuit voltage during use of bipolar electrosugery. Then the control voltage goes to the PWM to create the proper HV power supply voltage for the selected wattage.

f. The CPU sends signals to the output multiplexer, when the ES apparatus receptacles are activated, and then to the mode selector logic to enable the correct pulse generation. This pulse series turns the RF drive transistors on and off at the correct rate for the selected mode of operation. The correct routing of the output power is also selected by the CPU and its output multiplexer by enabling the correct output relays. These relays direct the output power to the activated receptacle.

g. The two operating modes of the alarm circuitry are single and dual pad modes. In the single pad mode, the RF current is used to detect cable to pad continuity. An alarm tone sounds in this mode only if impedance exceeds a preset hardware limit. The alarms are created by signals sent to the CPU's input multiplexer where they are decoded. The CPU sends the necessary signals to the output multiplexer to activate the alarm indicator and alarm tone. In the dual pad mode, the patient return electrode, attached to the ES apparatus, is used to detect the pad to patient resistance. This is accomplished by sending a small RF current from one pad to the other pad through the patient. The detection circuitry converts the RF current into a DC voltage. This voltage is then directed to an analog to digital converter where it is analyzed by the CPU.

NOTE

Dual pad patient return electrodes are not furnished with the ES apparatus.

4-9. Bipolar display PCB.

a. The bipolar display PCB is used as the digital display for watts and to illuminate the bipolar indicator. The signals for the display are derived from the multiplexed display driver on the MD/C PCB and the signals for the indicator are derived from the RF circuitry.

b. An audible tone device is also incorporated onto this PCB. The frequency selector for the tone is accomplished by circuitry on the MD/C PCB. The mode indicator tone volume is controlled by a potentiometer mounted on the back panel of the ES apparatus. In the event of an alarm condition, the volume potentiometer is bypassed and a full volume tone is sounded.

c. The BD PCB is illustrated in figure 4-3 and the schematic diagram for the BD PCB is shown in figure 4-4.

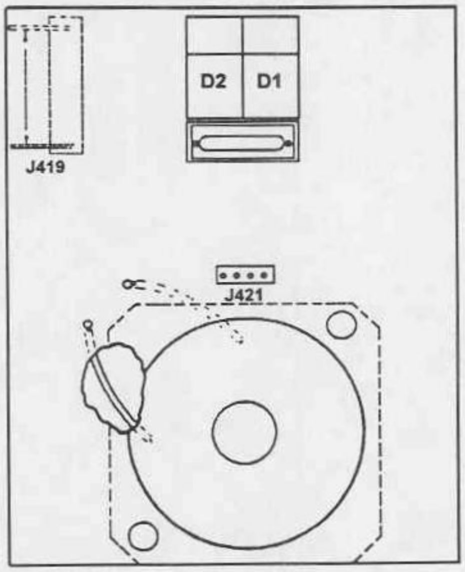

D2
D1
J419
J421

Figure 4-3. Bipolar display PCB.

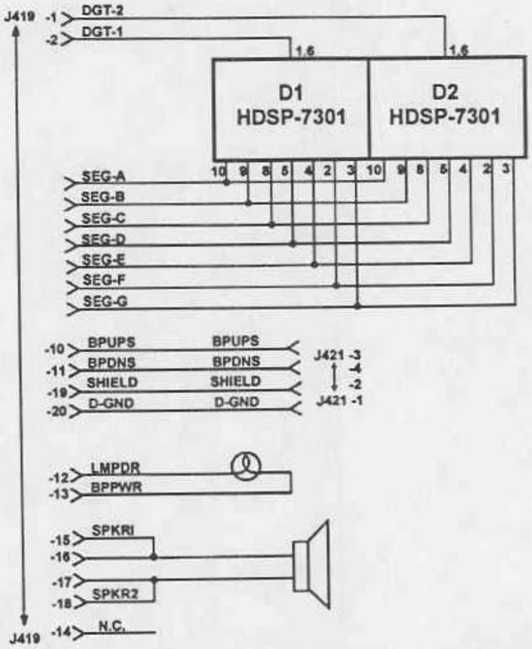

J419 -1
DGT-2
-2
DGT-1
1,6
1,6
D1
HDSP-7301
D2
HDSP-7301
10
9
8
5
4
2
3
10
9
8
5
4
2
3
SEG-A
SEG-B
SEG-C
SEG-D
SEG-E
SEG-F
SEG-G
-10
BPUPS
BPUPS
-11
BPDNS
BPDNS
-19
SHIELD
SHIELD
-20
D-GND
D-GND
J421 -3
-4
-2
J421 -1
-12
LMPDR
-13
BPPWR
-15
SPKRI
-16
-17
-18
SPKR2
J419 -14
N.C.

Figure 4-4. Bipolar display PCB schematic.

4-10. Power supply/RF PCB.

a. Power supply.

(1) The power supply is an off-line DC to DC switching converter operating at 80 kHz. Input switching is supplied by a voltage doubler, two hold-up capacitors, and four power field effect transistors (FETs) in a bridge configuration. The FETs drive the power transformer (T3) primary at 320 Vp and varying duty cycles. The power transformer rectified secondary voltage is filtered by a 0.75 mH inductor and two 15 μF capacitors which convert a constant amplitude variable duty cycle input to a variable DC output. The duty cycle is controlled by a 3526 IC regulator with emitter followers to drive transformers T1 and T2 which switch the power FETs. The IC contains a sawtooth oscillator, pulse steering logic, and a comparator. The error voltage on pin 1 varies from +0.5 to +3.5 volts to change the output duty cycle. The power transformer has snubber networks to limit voltage spikes.

(2) The power supply control uses an operational amplifier (Op Amp) within the 3526 IC to amplify the difference between a feedback fraction of the DC output and a reference voltage. The reference voltage is generated by the CPU and scaled as the square root of the front panel wattage setting. There is a DC current limit implemented with a comparator and pulse stretcher. The pulse stretcher shuts down the power supply's control IC for about 0.33 second and then soft starts the supply. A resistor-capacitor (R-C) network on pin 7 of the 3526 IC provides power on reset.

(3) Low voltage supplies of +12 VDC and +5 VDC are regulated with 3-pin ICs. The rough DC is generated by a transformer, rectifier, and capacitor circuit. There are no low voltage adjustments.

CAUTION

The power FETs and other components of the supply heat sink are at electrical power source potential. Use extreme caution when servicing this circuitry.

b. RF output.

(1) This circuitry amplifies the CPU on/off signals to the level required by the front panel wattage settings. Current limiting and peak voltage limiting circuits prevent damage under extreme load conditions. Varying the supply voltage controls power. Both DC supply and RF current limit levels are calibrated for each mode (CUT, COAG, BLEND 2, and BIPOLAR). The output tuning and transformer windings ratio is different for CUT and COAG waveforms and is selected by a relay. Eight power FETs act as RF switching elements. A current sampling resistor at the source provides input to a current limiting circuit. The gate drive is at a +12 VDC. The drains have diodes in series to allow the RF output transformer primary voltage to swing negative in COAG mode. The CUT mode waveform drive is a 50 percent cycle with a 1μs on time period. The COAG mode drive waveform is generated by turning on the FETs for 2 μs every 32 μs.

(2) RF control uses a set-reset flip-flop toggling at 500 kHz in CUT mode. The flip-flop is set by the turn on (TON) signal which turns on the output FETs. The flip-flop is cleared by the turn off (TOFF) signal or by a current limit pulse from the LM306 comparator. The current limit reference to turn the IC on is supplied by the CPU and varies as the square root of power with an offset at low powers. When peak voltage limiting occurs, the reference voltage to the LM306 comparator is reduced to lower the output pulse width. At high load impedances, a one-shot is triggered by transformer primary voltages below -100 VDC. This one-shot turns on a FET to load the output and reduce high frequency risk currents.

(3) The FET output is relatively low impedance and its voltage compliance is limited by the choice of DC power supply voltage as the power control resembles a constant voltage source. Below a 300-ohm load, the current limit circuitry enforces a constant current characteristic. A peak detector and comparator provide RF indicator control. The bipolar control adds an Op Amp to the power supply feedback path. This amplifies the difference between the RF output peak voltage and the power supply set point voltage. The difference is added with the feedback supply voltage by injecting current into the feedback divider to reduce the supply under high impedance load conditions. Current injection is enabled only in the bipolar mode.

(4) All eight output FETs must be the same type. Check current matching in COAG mode by clipping a current transformer around the 0.2-ohm resistors.

(5) The PSRF PCB is illustrated in figure 4-5 and the schematic diagram for the PCB is contained in figures 4-6 and 4-7.

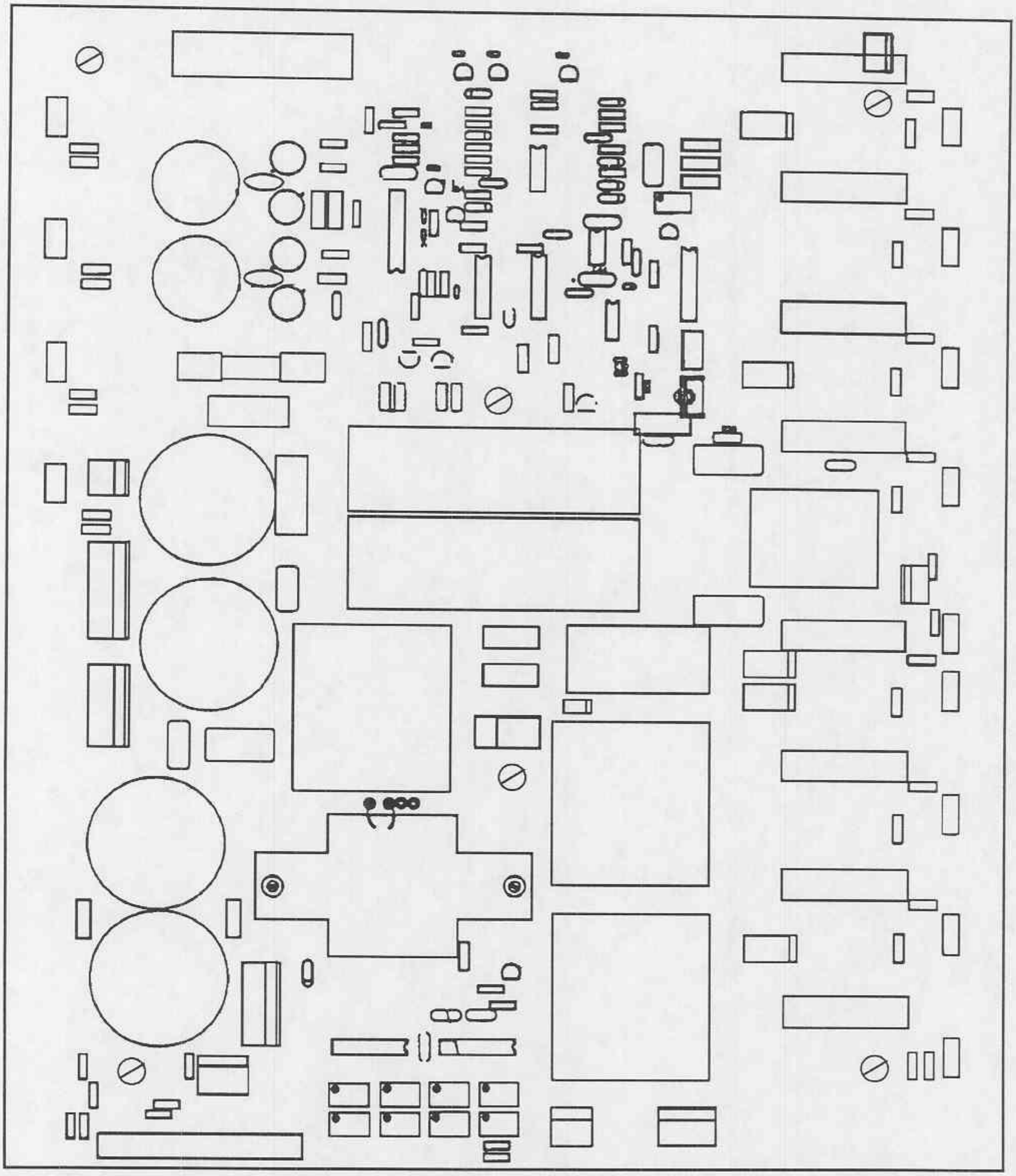


Figure 4-5. Power supply/RF PCB.

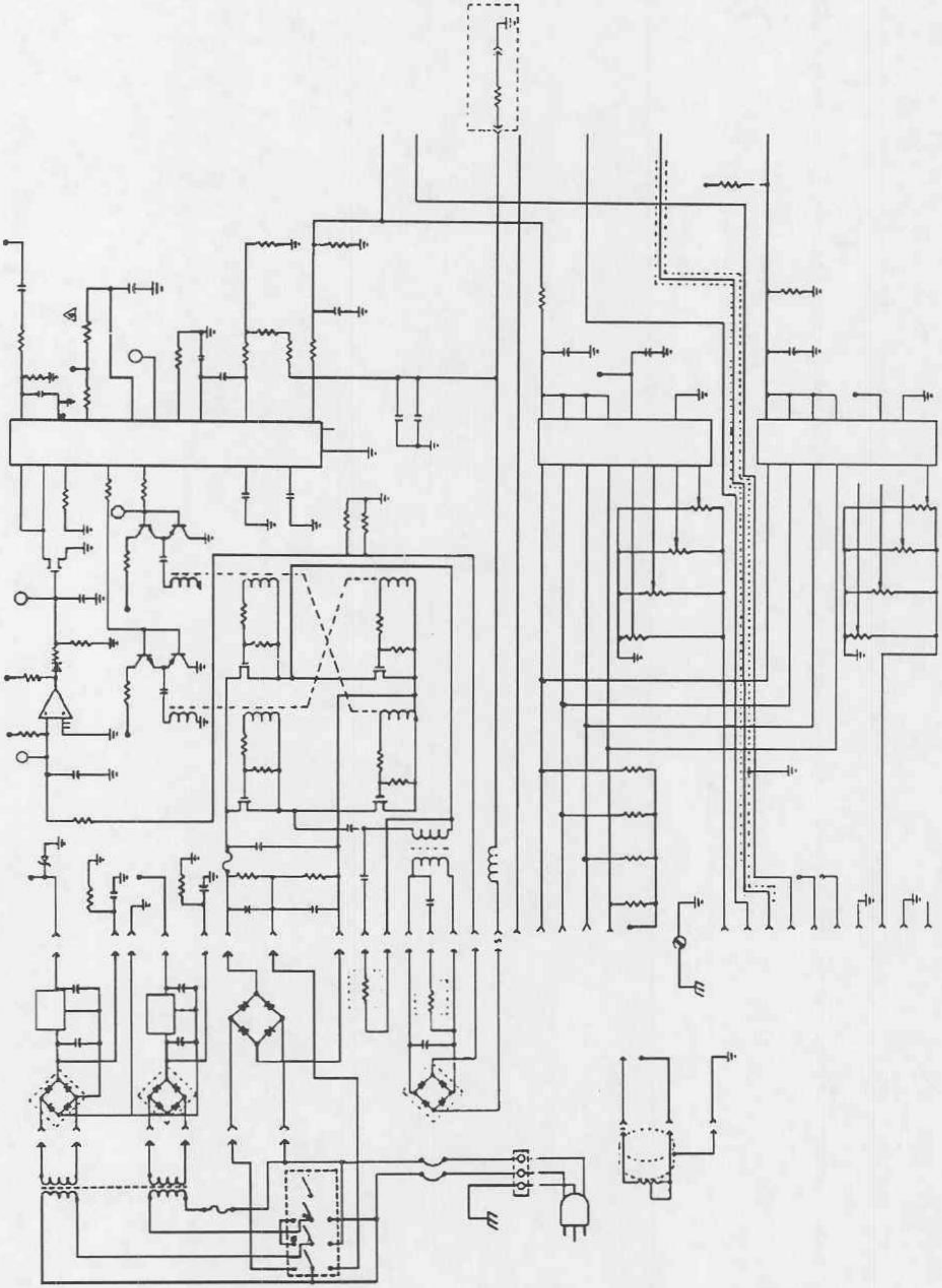


Figure 4-6. Power supply/RF PCB schematic.

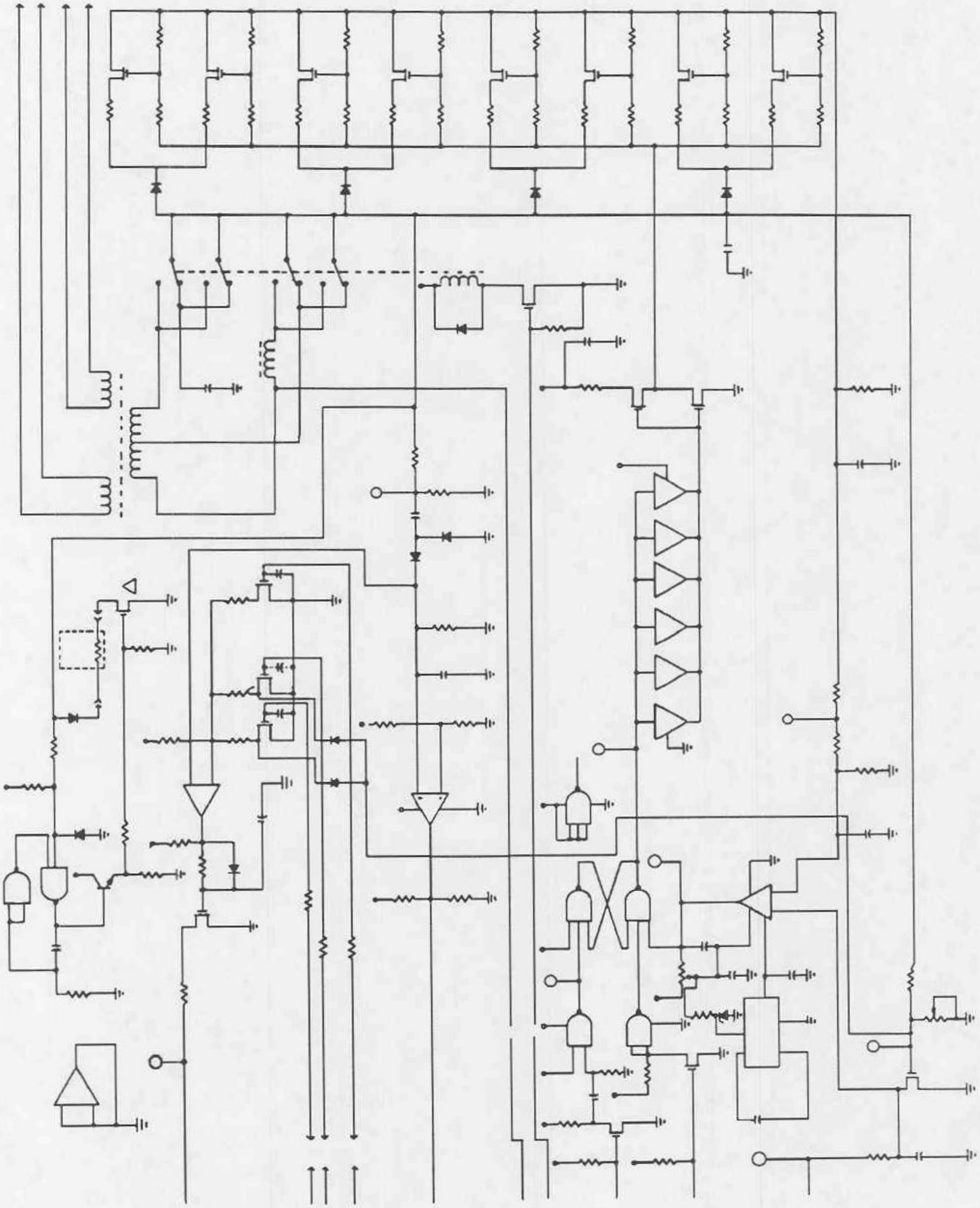


Figure 4-7. Power supply/RF PCB schematic (continued).

4-11. Monopolar display/control PCB.

a. This PCB has two major functions. The first is to be the main control element and the second is to be the interface between user inputs and the ES apparatus.

(1) The first function involves the CPU generating the proper RF drive for each selected mode, calculating and generating the power supply control voltage, calculating and generating the RF output stage current limit, and performing alarm monitoring when the ES apparatus is not activated.

(2) The second function involves the CPU receiving all keyboard switch signals from the front panel and performing the proper functional response (e.g., changing the digital display watts, changing CUT mode indicators, etc.). The CPU also processes all keyboard switch signals, after decoding by the interface PCB, and performs the proper algorithm to initiate the desired RF output.

b. The main control element on the CPU is an 8749 single-chip microprocessor with 2k of on-board erasable, programmable, read-only memory (EPROM). This chip, with its host of dedicated peripherals, performs the functional responses required of the CPU. The actual software program within the 8749 carries the brunt of the performance requirements of the CPU.

c. The major display requirements of the CPU are performed using an intersil display multiplexer (U3). This device is a universal eight-digit light emitting diode (LED) driver system. Internally, it contains all the circuitry necessary to interface a CPU to a LED display. Included on the chip is an 8 x 8 static memory array with storage for the displayed information, seven segment decoders, all the multiplex scan circuitry, and the high power digit and segment drivers. Consequently, the CPU is able to write the display information to this chip in binary coded decimal (BCD) system format and the display multiplexer completes the process. This stand-alone feature is used for almost all of the required display systems. The RF watts indicators and the alarm and remote switch indicators are individually activated by the CPU port lines. However, the ICM7218C is not capable of activating the mode indicators with sufficient power to make them fully visible through the translucent windows. To overcome this deficiency, segment H, the decimal point drive output of the ICM7218C, is individually gated with each of the eight digit drives to externally multiplex the mode indicator information. The resultant mode indicator drives are current boosted by U14, an ULN2803A, to drive the display LEDs. The external multiplexing is accomplished by U15 and U29.

d. Two digit drive lines and seven segment drive lines are bussed from the CPU to the BD PCB to control the bipolar display seven segment digits.

e. The alarm and remote indicators are not controlled by the ICM7218C. Individual CPU port lines are assigned to these two displays. Pins 12 and 16 activate these LED displays. The pull-up resistors (R14 and R17) are required to ensure that the outputs of the open collector driver pull high when its inputs are low. An additional circuit in parallel with the alarm LED is transistor Q1, which is turned on when the alarm indicator is illuminated. This transistor shorts out the volume control potentiometer and allows the alarm tone to be sounded at full volume.

f. The alarm tone frequency and its activation are both controlled by port lines (pins 10 and 11) of the 8749 microprocessor. These two control lines activate an on/off analog gate which controls the speaker and a second analog gate which increases the capacitance of a one-gate oscillator. The one-gate oscillator, a part of U7, is a typical R-C circuit. However, several additions are added to clarify the actual tone output. A large R-C filter (R21 and C8) is incorporated in the power input to U7 to completely eliminate all AC noise, that would be transmitted as amplitude and frequency modulation, superimposed on the oscillator output to the speaker causing a warbling effect. Components R31 and CR3 are added to change the duty cycle of the oscillator to fine tune the final tone output. The output of the oscillator is current boosted by a pair of drivers in U1. The resistor R1 in series with the speaker limits the maximum tone output.

g. The RF indicators are the only other elements not controlled by the display driver. Each of these indicators is controlled by an assigned port line of the CPU. The port line is current boosted by an open collector driver in U1. The indicators are further controlled by transistor Q3. This transistor must be on for the RF indicators to be illuminated. Transistor Q3 can be turned on through—

(1) an assigned port line (pin 13) when the ES apparatus is activated and the self-test is automatically completed, or

(2) the RF detection line from the PSRF PCB generates an RF output.

h. The 8749 microprocessor interacts directly with the ICM7218C on the CPU's data bus. For the CPU to be able to communicate with its peripherals, chip selects must be generated external to the CPU to activate the peripheral which is either "written to" or "read from." The falling edge of the address latch enable (ALE) line on the CPU indicates that a valid address is present on the data bus. A 74LS374, octal D-type latch (U6), is used to decode the address information into chip select signals to activate peripherals. The latch signal is only enabled if external memory is being addressed. This is decoded whenever either the read or write outputs of the CPU are activated by going low. The two signals are true negative. U22 performs the NOR function. R2 is used to shift the read enable for the address decoder to ensure that the decoded chip select remains valid during the CPU "read from" on the data bus. A low on an address line, the output of U6, is used as a chip select. Consequently, to ensure that only one peripheral is addressed at the same time, all external memory locations have addresses with all bits high except one.

i. There are eight memory locations. Three are read only and five are write only memories.

NOTE

One of the write-only memories has previously been described.

(1) The three read locations are used to enter the 22 user inputs. Front panel keyboard switch inputs number 14 and the remaining 8 are decoded activation inputs. The signals are divided into activation inputs, mode selection, and power up (Δ) and down (∇) keyboard switches. Each signal is separately addressable. Intergrated circuits U16, U23, and U24 are used to buffer these read signals onto the CPU data bus. These devices are 74LS240s, octal-inverting data bus drivers, with tri-state output capability. The chip selects, generated by U6 to control the output enable of these devices, places them on the CPU data bus.

(2) Two eight-bit digital-to-analog converters (dacs) are on the data bus. They are configured as write-only devices. One of these ICs (U26) is used to generate the power supply control voltage (ECON) and the other IC (U25) is used to generate the RF current limit analog voltage (ICON). The outputs of the two dacs are inverted, amplified with a gain of one, inverted again, and amplified again with a gain of two to provide the final output analog signals with a range of 0 to +5 VDC. The amplifiers are all contained in a quadruple operational amplifier (Quad Op Amp) chip (U27). Various capacitors (C29, C41, etc.) are used to limit interference.

(3) The fourth write only location is dedicated to U5, an eight-bit parallel, in-series out-shift register (74LS165). This output is used to gate the principal RF clock frequency to generate the final RF drive wave shape.

(4) The final write location is a 74LS375 (U17) which is an octal, D-type latch used in the activation circuitry.

j. A 8749 crystal is used to generate the 6 MHz clock requirement. The output is inverted to drive the clock inputs for the CPU.

k. The write pulse generated by the CPU is not able to meet all of the timing requirements of the various peripheral circuits. Consequently, U13 is used to phase shift and shorten the pulse width with respect to ALE. The output of U13 is internally programmed to be 2 MHz. The resultant output is then OR gated with various peripheral chip select lines to generate the required write pulses for these circuits.

l. For RF activation and deactivation drive generation, U28 is used to divide the crystal frequency from 6 MHz to 500 kHz. One half of U9 is configured as a toggle flip-flop to further divide the clock to 250 kHz. The two analog gates of U10 are used to select the on/off drive frequency of the RF drive pulse series. The selection is controlled by CPU port line P15. The clock is then steered to a three-input AND gate (U11) dedicated to RF TON and drive. RF TOFF is the inversion of RF TON. The clock is AND gated with the serial output of the shift register (U5). R-C circuit (R35, C29) is used to account for timing skews on the clock generation circuitry. R-C circuit (R36, C6) is required to stop RF interference from entering the shift register. The output signal of the AND gates are the drive pulses. Since the eight-bit shift register is cyclically loading itself while data is being shifted out, the drive train frequency of modulation is 250/8 = 31.25 kHz. To avoid RF interference problems with the CPU when the ES apparatus is activated, the CPU shuts itself off by setting the flip-flop in U9. This is clocked at power up to allow the CPU to operate. Two things can reset this flip-flop. One is an alarm condition and the other is a change in mode of operation. The energy (Q) output of this flip-flop is the third input to the enable AND gate for RF drive. Consequently, drive series, and therefore RF, are only generated when the CPU is shut off.

m. The 8749 microprocessor is shut down by pulling the input single step line to ground. When this occurs, ALE is no longer generated and the lower nibble of port 2 is configured to show the upper nibble of the CPU address. To keep the CPU input/output (I/O) constant when the CPU is shut down, IC U4, a 74LS374, is used to latch port 2 information. When ALE is halted, the chip has latched the last port 2 I/O configuration. Therefore, the CPU activating circuitry must detect several unique conditions as follows:

(1) No input(s).

(2) A change of input.

(3) An alarm condition.

n. An alarm condition is detected on the interface PCB and is an input line to the CPU. Transistor Q4 is required to ignore the alarm fault line when the unit is in bipolar mode. IC U20 is used to detect when no inputs are occuring. IC U17, in combination with IC U18 and IC U19, detects an input change. This is accomplished by the CPU writing to IC U17, a 74LS374, the current input configuration. The two-bit magnitude comparators constantly compare this input configuration to the decoded outputs from the interface PCB. If the two signals are not the same, pin 6 of IC U19 will go low with R-C circuit (R23, C13) providing time delay and moderate RF filtering to this line. This signal is then gated with the normally open input signal from IC U20 and the fault line from the interface PCB to generate the reset signal for the CPU single-step flip-flop.

o. This alarm circuit assembly is mounted vertically at the front panel shield. It contains the patient circuit ES apparatus functions of input, output receptacle selection, and patient return electrode monitoring. This assembly has isolated high voltage and patient connected circuitry.

p. Input circuits comprise an isolated power source, comparators to detect keyboard switch closure, and optical couplers. The power source is two flyback converters and two toroid transformers. The handswitch circuits use three comparators to detect active to CUT, active to COAG, CUT to COAG, and active to CUT to COAG connections. These codes for CUT and COAG increase and decrease power. The remaining input circuits simply have resistors in series with opto-couplers to limit current. There are four isolated circuits, each with its own transformer winding for power.

q. The ES apparatus has three possible RF output receptacles. Selection of a receptacle is accomplished by a single pole, normally open, high voltage relay. The CPU turns on the relays using bipolar drivers on the interface PCB. A CPU controlled delay between relay closure and initiation of RF drive reduces relay contact wear. High voltage capacitors (0.0047 μF) in series with the RF output and return provides the primary patient protection against electrocution.

r. The fault circuitry measures the pad-to-pad resistance of dual-pad patient return electrodes (not furnished with the ES apparatus) or the wiring resistance of single-pad patient return electrodes. A micro-switch in the connector is opened for dual-pad patient return electrodes and selects the appropriate alarm signal paths. Resistance is measured as the load on a transformer secondary. The secondary is resonated by two 0.22 μF capacitors and the reflected primary load is sensed by a synchronous detector. Four clocked complementary metal oxide semi-conductor (CMOS) switches perform synchronous detection. The oscillator is tuned to the transformer by a potentiometer. The detector output is amplified and input to four comparators. Three comparators are used for dual-pad patient return electrodes. The fourth comparator provides a hard-wired alarm limit at 20 ohms.

s. PCB illustrations and schematics are provided as follows:

(1) Monopolar display/control PCB — figure 4-8.

(2) Monopolar display/control PCB schematics — figures 4-9 and 4-10.

(3) Interface PCB — figure 4-11.

(4) Interface PCB schematic — figure 4-12.

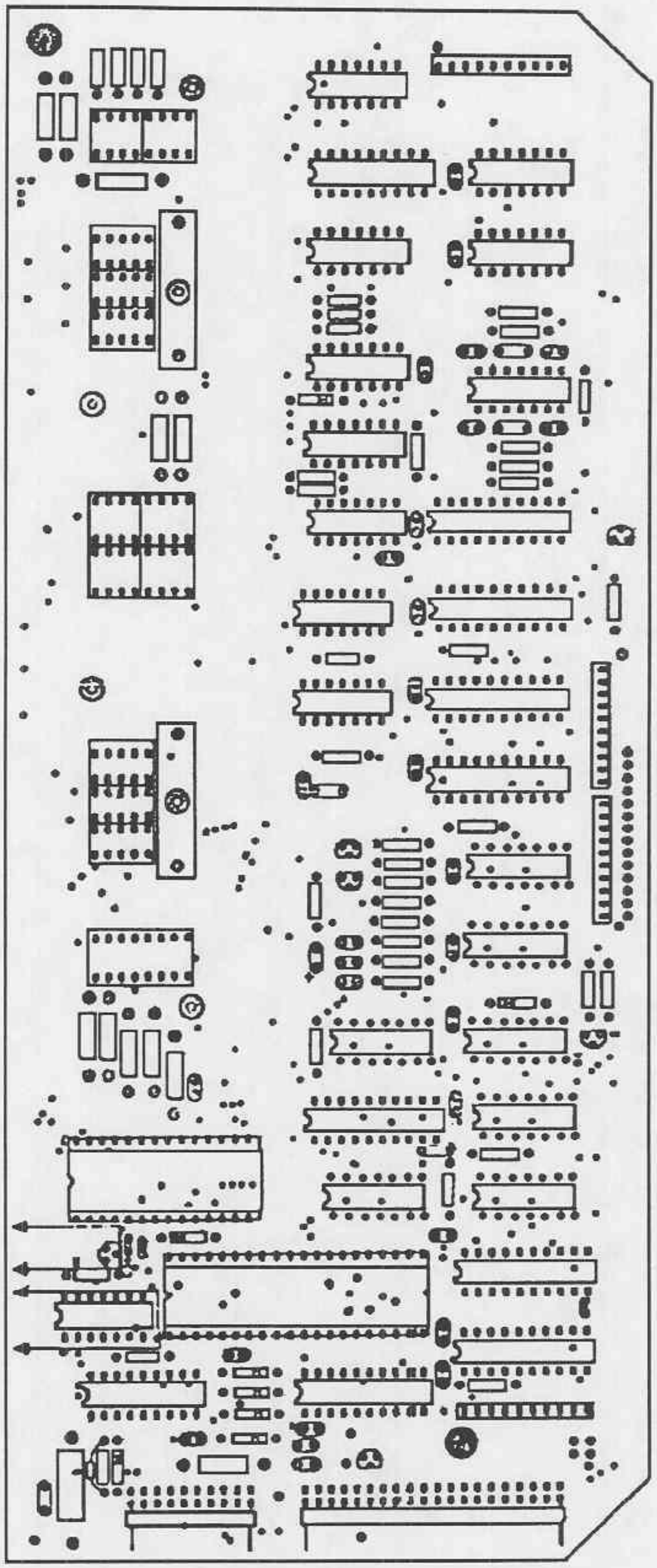


Figure 4-8. Monopolar display/control PCB.

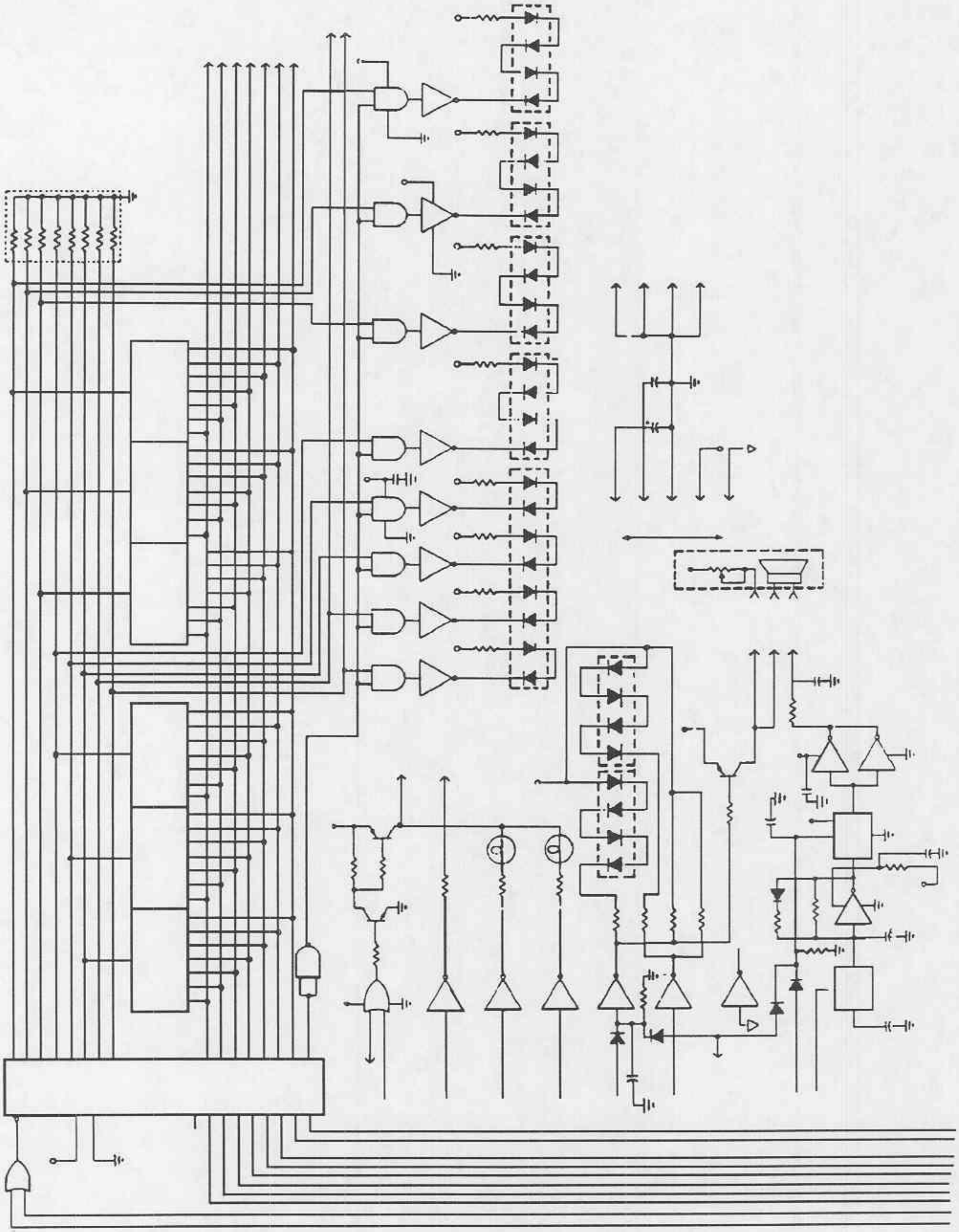


Figure 4-9. Monopolar display/control PCB schematic.

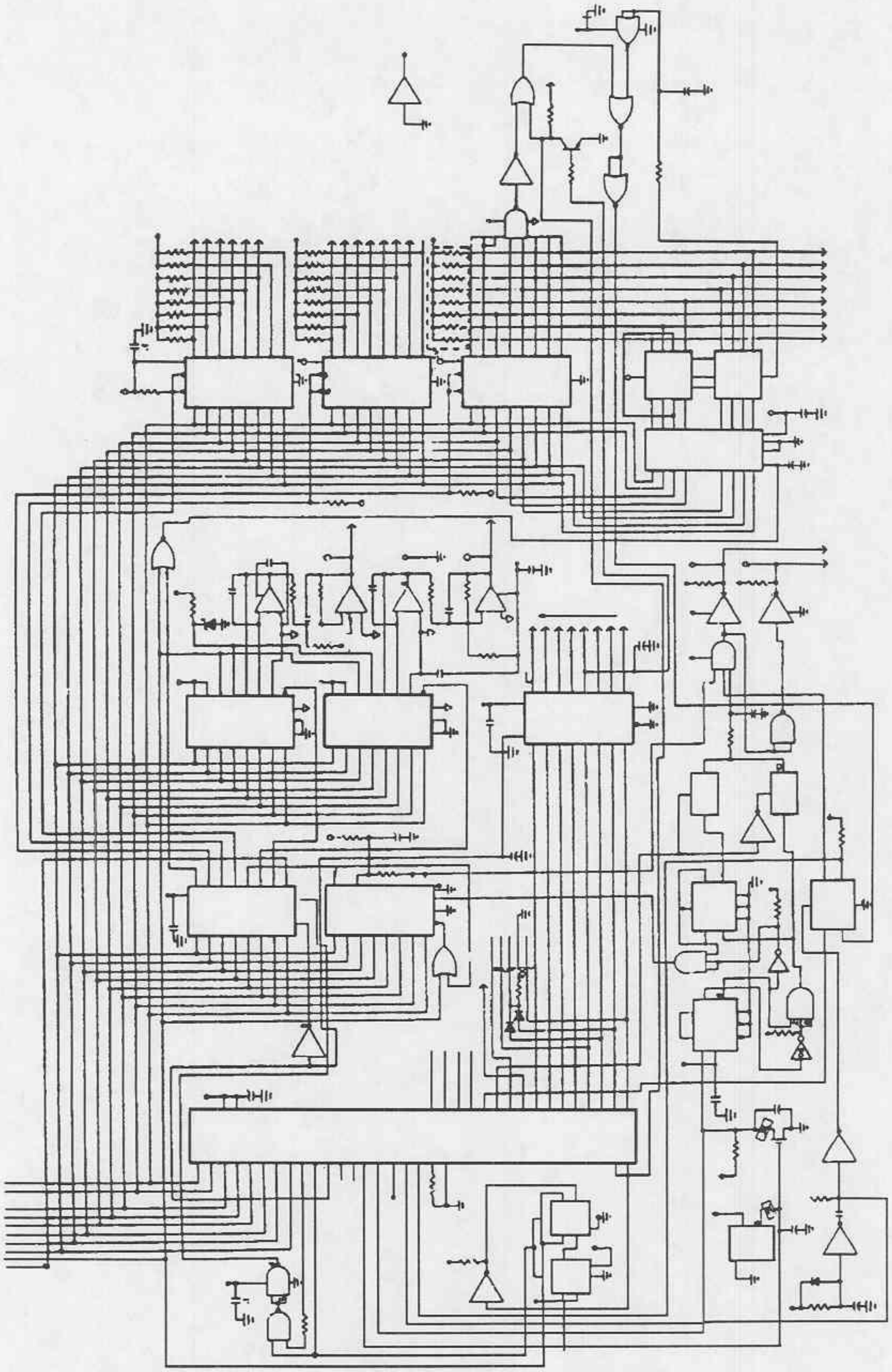


Figure 4-10. Monopolar display/control PCB schematic (continued).

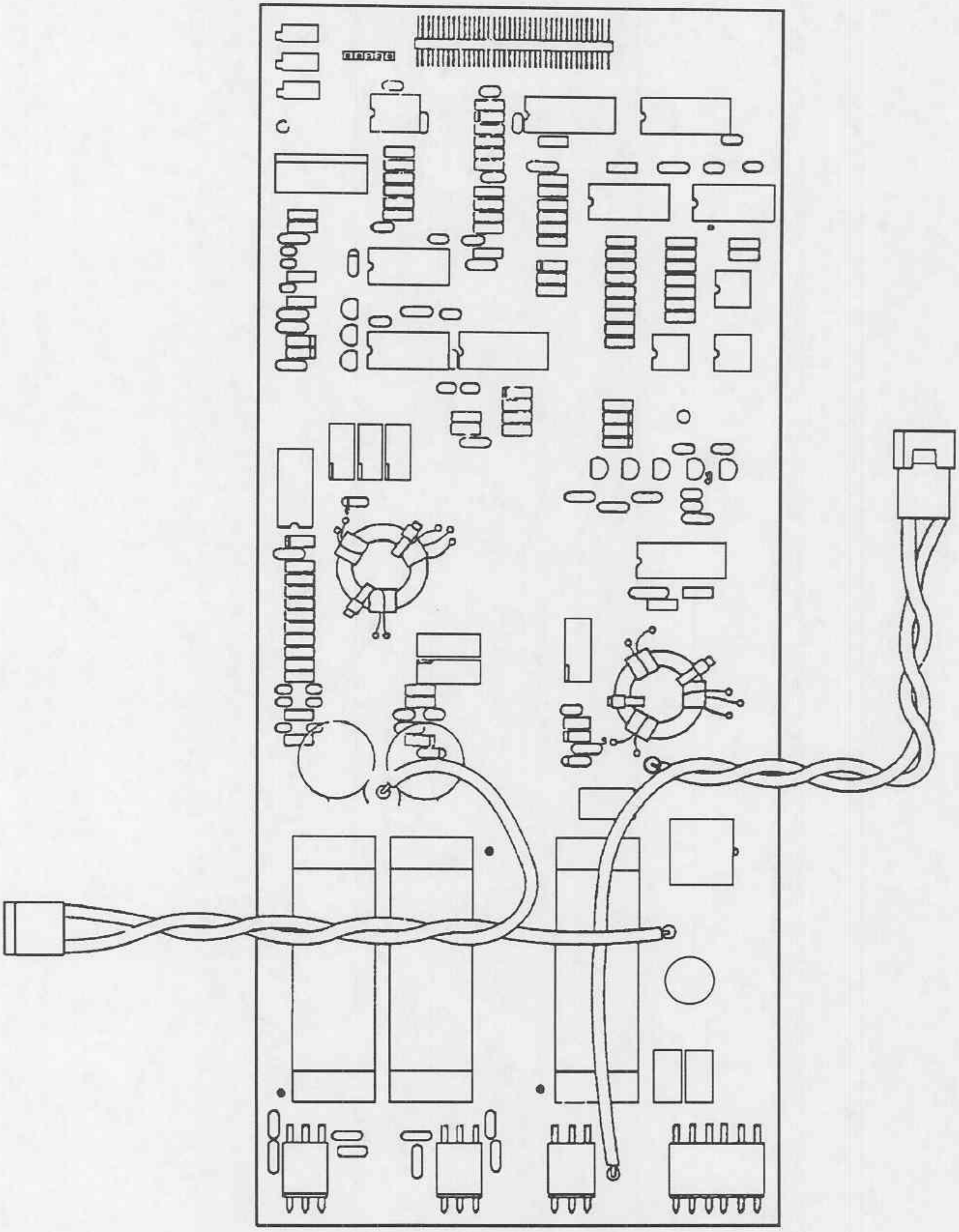


Figure 4-11. Interface PCB.

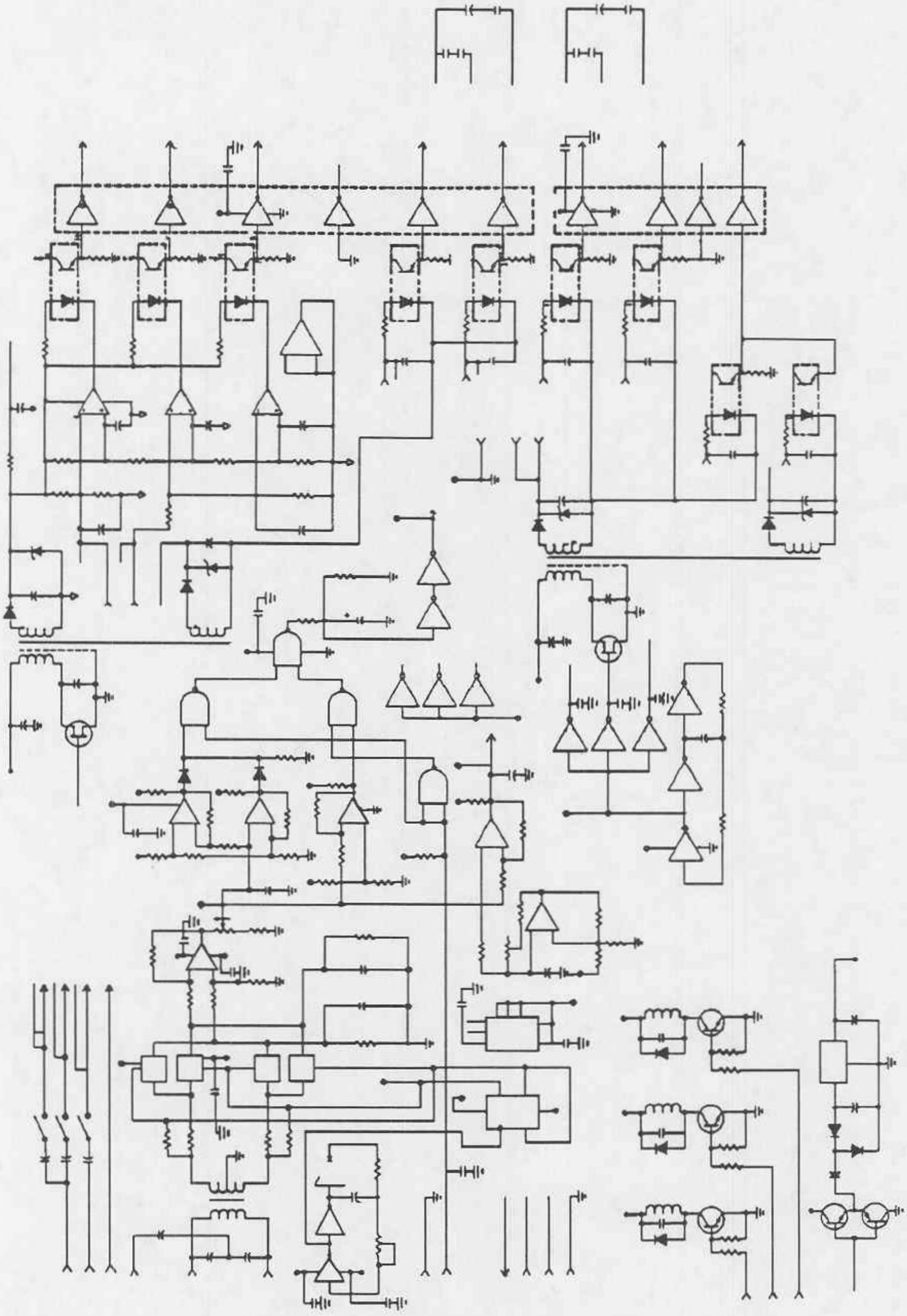


Figure 4-12. Interface PCB schematic.

Section III. MAJOR ASSEMBLY, PCB, AND COMPONENT LOCATIONS/INTERCONNECTIONS

4-12. General.

This section uses pictorials to illustrate the location and interconnections of assemblies, PCBs, and major components. Their locations are depicted in figure 4-13.

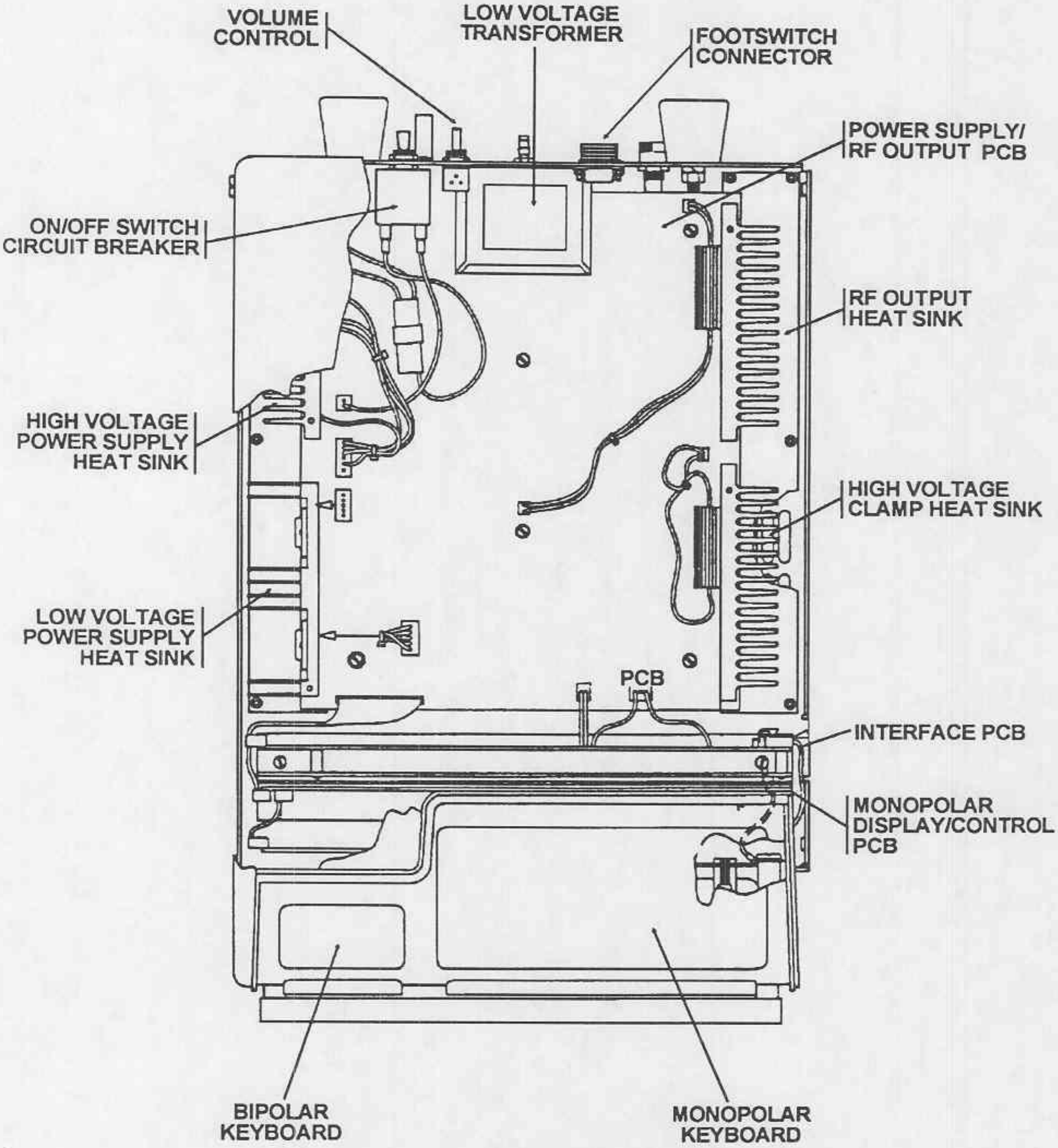

VOLUME CONTROL
LOW VOLTAGE TRANSFORMER
FOOTSWITCH CONNECTOR
POWER SUPPLY/ RF OUTPUT PCB
ON/OFF SWITCH CIRCUIT BREAKER
RF OUTPUT HEAT SINK
HIGH VOLTAGE POWER SUPPLY HEAT SINK
HIGH VOLTAGE CLAMP HEAT SINK
LOW VOLTAGE POWER SUPPLY HEAT SINK
PCB
INTERFACE PCB
MONOPOLAR DISPLAY/CONTROL PCB
BIPOLAR KEYBOARD
MONOPOLAR KEYBOARD

Figure 4-13. Assembly, PCB, and component locations.

4-13. Cabling/wiring interconnections.

a. Cabling/wiring interconnections with electronic plug (P) and jack (J) connectors are identified in figures 4-14 and 4-15.

b. Call-outs associated with each set of connectors (fig 4-14 and fig 4-15) are used to identify their pin functions identified in table 4-1.

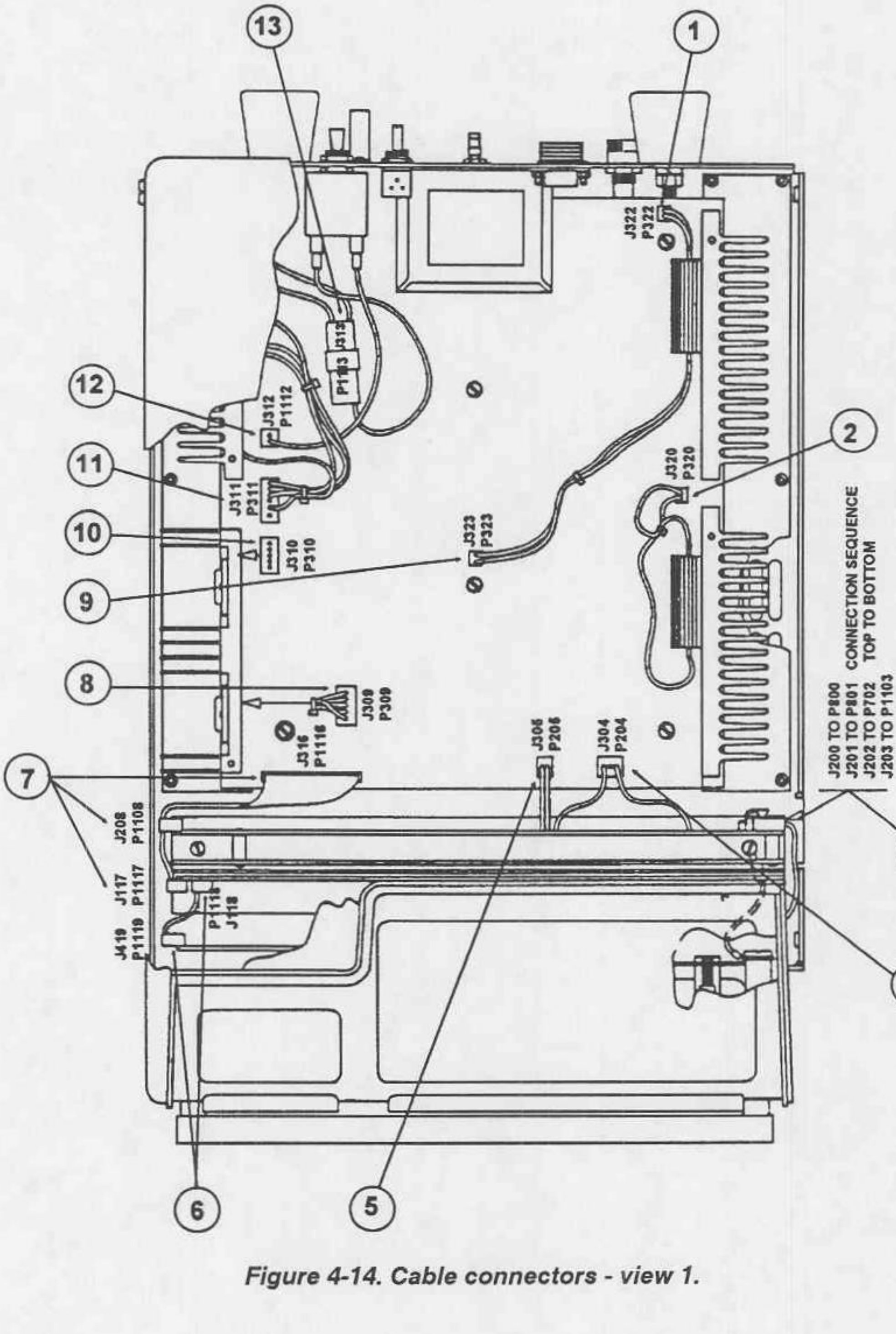

13
1
J322
P322
J313
P1113
12
J312
P1112
11
J311
P311
10
J310
P310
9
J323
P323
2
J320
P320
8
J309
P309
J316
P1116
J306
P206
J304
P204
J200 TO P800
J201 TO P801
J202 TO P702
J203 TO P1103
CONNECTION SEQUENCE
TOP TO BOTTOM
3
7
J208
P1108
J117
P1117
J419
P1119
P1118
J118
4
6
5

Figure 4-14. Cable connectors - view 1.

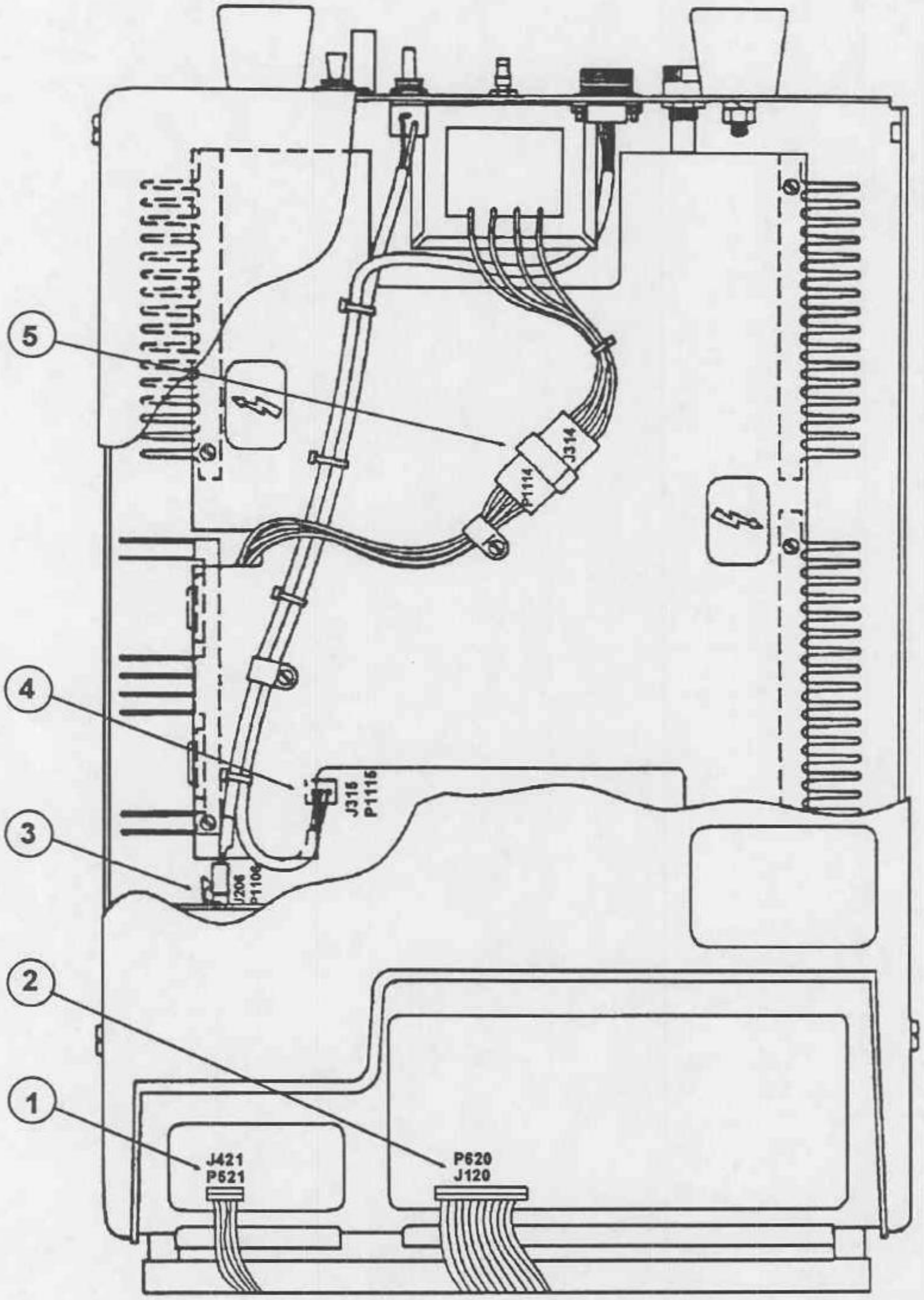

5
J314
P1114
4
J315
P1115
3
J206
P1106
2
1
J421
P521
P620
J120

Figure 4-15. Cable connectors - view 2.

Table 4-1. Connector pin functions.

CABLE CONNECTORS - VIEW 1

CALL-OUT NO.	JACK/PLUG NO.	PIN	FUNCTION
1	J322/P322	1	RF output heat sink
		2	RF output heat sink
2	J320/P320	1	Q5 drain
		2	HV clamp resistor
3	J200/P800	1	handswitch active
		2	handswitch "COAG"
		3	handswitch "CUT"
	J201/P801	1	accessory active
		2	accessory "COAG"
		3	accessory "CUT"
	J202/P702	1	bipolar out 1
		2	bipolar switch
		3	bipolar out 2
	J203/P1103	1	alarm switch 1
		2	alarm switch 2
		3	no connection
		4	no connection
		5	alarm return 1
		6	alarm return 2
4	J304/P204	1	monopolar RF
		2	no connection
		3	RF return
5	J305/P205	1	bipolar RF 1
		2	bipolar RF 2
6	J118/P1118 J419/P1119	1	digit 1
		2	digit 2
		3	segment A
		4	segment B
		5	segment C
		6	segment D
		7	segment E
		8	segment F
		9	segment G
		10	bipolar up
		11	bipolar down
		12	lamp drive
		13	bipolar power
		14	speaker 1
		15	speaker 1
		16	speaker 2
		17	speaker 2
		18	shield
		19	digital ground
		20	digital ground
7	J117/P1117 J208/P1108 J316/P1116	1	digital ground
		2	digital ground
		3	+5 VDC
		4	+5 VDC
		5	+12 VDC
		6	+12 VDC
		7	-5 VDC
		8	analog ground
		9	ECON voltage
		10	ICON voltage
		11	alarm fault
		12	RF sense
		13	no connection
		14	no connection

Table 4-1. Connector pin functions - continued.

		15	volume
		16	volume
		17	no connection
		18	no connection
		19	bipolar enable
		20	"CUT" enable
		21	"COAG" enable
		22	"BLEND" enable
		23	bipolar relay
		24	handswitch relay
		25	accessory relay
		26	"CUT" relay
		27	alarm pulse width
		28	no connection
		29	handswitch "CUT"
		30	handswitch "COAG"
		31	handswitch up/down
		32	accessory switch "CUT"
		33	accessory switch "COAG"
		34	footswitch "CUT"
		35	footswitch "COAG"
		36	bipolar footswitch
		37	no connection
		38	no connection
		39	on
		40	off
8	J309/P309	1	+5 VDC filter capacitor
		2	+12 VDC filter capacitor
		3	low voltage return
		4	+12 VDC
		5	+5 VDC
9	J323/P323	1	RF output heat sink
		2	RF output heat sink
10	J310/P310	1	high voltage DC source
		2	high voltage DC source
		3	high voltage DC snubber
		4	high voltage DC return
		5	high voltage DC position
11	J311/P311	1	line high
		2	line low
		3	line transformer
		4	no connection
		5	line snubber
		6	no connection
12	J312/P1112	1	AC neutral
		2	no connection
13	J313/P1113	1	AC 120 volts
		2	no connection
		3	no connection
CABLE CONNECTORS - VIEW 2			
1	J421/P521	1	shield
		2	digital ground
		3	"BIPOLAR" up switch
		4	"BIPOLAR" down switch
2	J120/P620	1	shield
		2	digital ground
		3	"PURE" "CUT" switch
		4	"BLEND 1" switch
		5	"BLEND 2" switch

Table 4-1. Connector pin functions - continued.

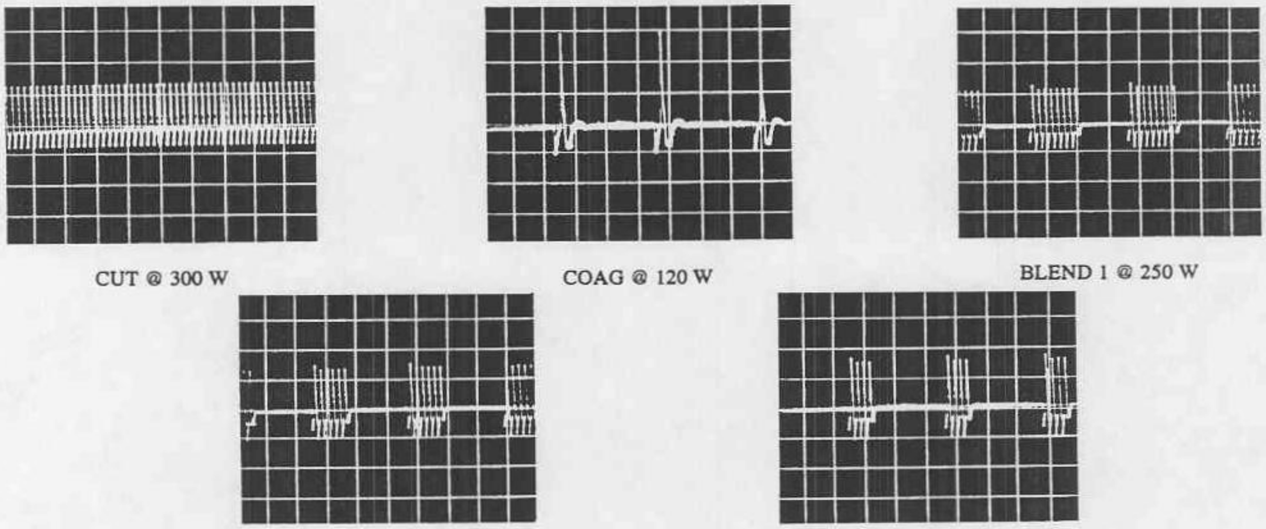
		6	"BLEND 3" switch
		7	"CUT" up switch
		8	"CUT" down switch
		9	"STANDBY" switch
		10	"BIPOLAR" "FOOTSWITCH"
		11	"READY" switch
		12	"MONOPOLAR" "FOOTSWITCH"
		13	"COAG" up switch
		14	"COAG" down switch
3	J206/P1106	1	monopolar footswitch "CUT" D
		2	monopolar footswitch "COAG" A
		3	monopolar footswitch common C
		4	bipolar footswitch common C
		5	bipolar footswitch desicate A
		6	footswitch ground B
4	J315/P1115	1	+12 VDC
		2	volume control
		3	shield ground
5	J314/P1114	1	5 VDC unregulated in
		2	5 VDC return
		3	12 VDC unregulated in
		4	12 VDC unregulated return

Section IV. TROUBLESHOOTING

4-14. General.

a. This section contains troubleshooting procedures for the ES apparatus that supplement the procedures provided in chapter 3, section VII.

b. This section also contains oscilloscope waveforms for monopolar mode outputs of the ES apparatus as well as other voltage and current waveforms (fig 4-16 through fig 4-19).



CUT @ 300 W

COAG @ 120 W

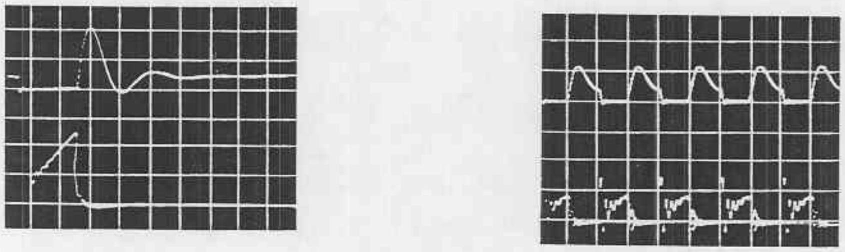
BLEND 1 @ 250 W

BLEND 2 @ 200 W

BLEND 3 @ 150 W
LOW VOLTAGE COAG @ 99 W

ALL WAVEFORMS SEEN ACROSS A 300 OHM LOAD
HORIZONTAL SENSITIVITY - 10 μs/cm
VERTICAL SENSITIVITY - 500 V/cm

Figure 4-16. Monopolar output waveforms.

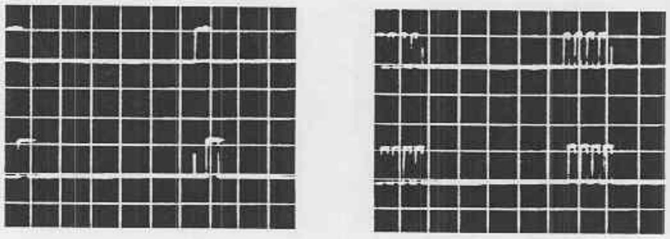


COAG @ 30 W

CUT @ 75 W

TOP VERTICAL - 100 V/DIV
BOTTOM VERTICAL - 1 A/DIV
HORIZONTAL - 1 µs/DIV

Figure 4-17. Output FET voltage and current waveforms.



COAG

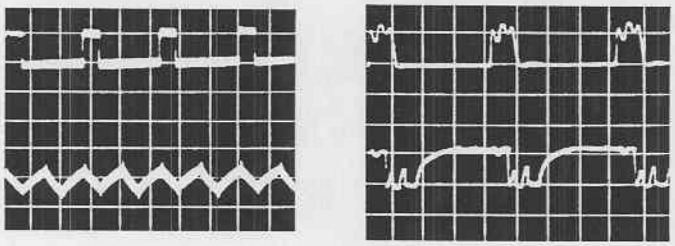
TOP TRACE - TON
BOTTOM TRACE - TOFF

BLEND 3

TOP TRACE - TON
BLEND TRACE - TOFF

VERTICAL - 10 V/DIV
HORIZONTAL - 5 µs/DIV

Figure 4-18. RF output FET gate drive waveforms at Q18 and Q19 drains.



U7, PIN 16

CURRENT IN L2

Q1 - 8 GATES

U3, PIN 7, RF CURRENT
LIMIT CONTROL

TOP VERTICAL - 10 V/DIV
BOTTOM VERTICAL - 10 V/DIV
HORIZONTAL - 10 µs/DIV

TOP VERTICAL - 10 V/DIV
BOTTOM VERTICAL - 10 V/DIV
HORIZONTAL - 0.5 µs/DIV

Figure 4-19. Power supply and RF current limit waveforms.

4-15. DS/GS troubleshooting procedures.

a. Perform the initial start-up procedures (para 2-2).

b. Pull the electrical power toggle switch, located on the back panel of the ES apparatus, up to the "|" symbol.

c. Observe the control panel. The following control panel actions will automatically occur (fig 4-20 and fig 4-21).

(1) An audible tone momentarily sounds.

(2) The three digital displays show "8"s.

(3) All 13 indicators illuminate.

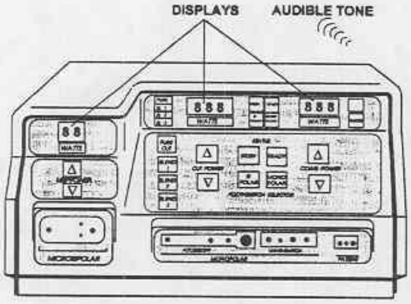


Figure 4-20. Self-test displays.

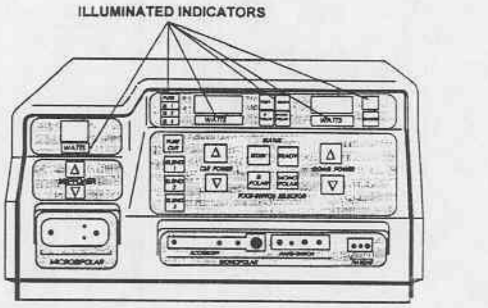


Figure 4-21. Self-test illuminated indicators.

NOTE

> If you did not verify all of the above actions, push the electrical power toggle switch back down to the "O" symbol and then pull it upward again to the "|" symbol.
>
> The ES apparatus automatically switches to the "STDBY" mode after 5 to 7 seconds.

d. Continue to observe the control panel. The following control panel actions will automatically occur (fig 4-22).

(1) The three digital displays show "- - -."

(2) The yellow "STDBY" indicator illuminates.

e. If the self-test fails, follow troubleshooting table 4-2 below and perform the specified actions.

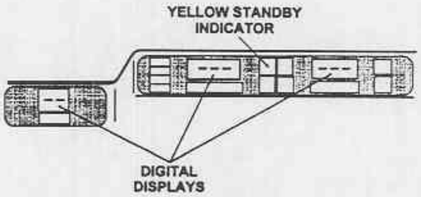


Figure 4-22. Standby mode.

Table 4-2. DS/GS self-test troubleshooting.

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE MAINTENANCE
SELF-TEST MODE FAILS TO START WHEN ES APPARATUS IS POWERED UP.		
	Electrical power is not connected.	Connect electrical power.
	Back panel fuse is defective.	Replace back panel fuse.
	Low voltage power at J309, pin 4 is not +12 VDC ±0.02 V and J309, pin 5 is not -5 VDC ±0.025 V.	Replace PSRF resistors and/or capacitors.
	Malfunctioning power supply transformers.	Replace transformers.
	Bridge rectifiers on low voltage. Heat sink defective.	Replace heat sink.
	Oscillator Y1 on MD/C PCB not operating at 6 MHz.	Repair or exchange PCB.

f. If the ES apparatus does not activate in PURE CUT mode set at 150 watts, follow troubleshooting table 4-3 and perform the specified actions.

Table 4-3. PURE CUT troubleshooting.

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE MAINTENANCE
NO OUTPUT IS GENERATED IN PURE CUT MODE SET AT 150 WATTS.	PURE CUT is not activated.	Repair or exchange PSRF PCB.
	Accessory output does not show 150 watts.	Repair or exchange PSRF PCB or connector.
	Fuse F1 on PSRF PCB does not have continuity.	Replace fuse.
	Defective transistors Q26 through Q29 on PSRF PCB.	Replace transistors.
	Transformers T1 and T2 not at 40 kHz.	Replace transformer(s).
	No ramping DC voltage at capacitors C36 and C37 on PSRF PCB when keyboard is activated.	Replace defective components.
	Diodes CR1 through CR5 defective on PSRF PCB.	Replace defective diodes.
	RF output FETs Q1 through Q9 on PSRF PCB are short circuited.	Replace defective FETs.
	Over current circuit is latched on PSRF PCB.	Check ECON voltage at pin 1, IC U7. Replace defective circuit components.
	No voltage at transformer TP3 on MD/C PCB.	Replace main ribbon cable assembly.
	No voltage present at IC U27 on MD/C PCB.	Replace defective circuit components.
	No 80 kHz signal on pin 12 and pin 16, IC U7.	Replace defective circuit components.
	No 40 kHz signal on pin 13 and pin 16, IC U7.	Replace defective circiut components.

g. If the ES apparatus does not activate in CUT, COAG, or BIPOLAR modes when using a monopolar footswitch, follow troubleshooting table 4-4 and perform the specified actions.

Table 4-4. Monopolar footswitch mode troubleshooting.

SYMPTOM

POSSIBLE CAUSE

CORRECTIVE MAINTENANCE

UNIT DOES NOT ACTIVATE FOOTSWITCHING OUTPUT IN CUT, COAG, OR BIPOLAR WITH FOOTSWITCH.

Footswitch assembly does not show continuity.

Repair footswitch assembly.

Capacitor C230 on interface PCB not at +10 VDC.

Check transformer T202, diode CR 204, or diode CR 214 for shorting and replace as required.

Optoisolators OPT7 through OPT 7 have an emitter turned on.

Troubleshoot circuitry and replace defective optoisolator(s) or circuit components.

---

h. If the ES apparatus does not activate in the CUT or COAG modes when using a handswitching accessory, follow troubleshooting table 4-5 and perform the specified action.

Table 4-5. Monopolar handswitch mode troubleshooting.

SYMPTOM

POSSIBLE CAUSE

CORRECTIVE MAINTENANCE

UNIT DOES NOT ACTIVATE HANDSWITCHING OUTPUT IN CUT OR COAG WITH HANDSWITCH.

Handswitching accessory does not have continuity.

Replace handswitching accessory.

Capacitor C219 on interface PCB not at +10 VDC.

Check for 100 kHz signal at transformer TP5, check for shorting of transformer T202, transistor Q4, or diodes CR204 and CR214 on interface PCB. Replace defective circuit components.

Optoisolators OPT4 through OPT6 on the interface PCB are not turned on.

Replace defective circuit components.

---

i. If the ES apparatus does not activate when using the handswitching forceps, follow troubleshooting table 4-6 and perform the specified actions.

Table 4-6. Handswitching forceps (bipolar) troubleshooting.

SYMPTOM

POSSIBLE CAUSE

CORRECTIVE MAINTENANCE

UNIT DOES NOT ACTIVATE WITH HANDSWITCHING FORCEPS.

Bipolar forceps and cord do not show continuity.

Replace cord and forceps.

Capacitor C216 on interface PCB not at +10 VDC.

Check transformer T2, transistor Q4, or diodes CR215 and CR216 for shorting on the interface PCB. Replace defective circuit components.

Optoisolator OPT3 on interface PCB not turned on.

Replace defective circuit components.

j. If the alarm either does not operate or it operates continuously, follow troubleshooting table 4-7 and perform the specified actions.

Table 4-7. Alarm troubleshooting.

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE MAINTENANCE
NO ALARM OR CONSTANT ALARM.	When the power is off and the patient return electrode is disconnected, J203, pin 5 or 6 does not show continuity.	Replace patient receptacle.
	When a mode using a patient return electrode is activated, there is an open circuit at J203, pin 5 or 6.	Replace patient receptacle.
	Transformer TP3 on interface PCB does not have +2.19 to +4.89 VDC.	Replace transformer.
	J117, pin 11 to J208, pin 11 is not electronically continuous.	Replace main ribbon cable assembly.
	J117, pin 11 on MD/C PCB does not have +2.19 to +4.89 VDC.	Replace main ribbon cable.

k. Push the electrical power toggle switch, located on the back panel of the ES apparatus, to the "O" symbol.

Section V. REPAIR PROCEDURES

4-16. General.

a. Procedures for disassembly; replacement of assemblies, PCBs, and major components; and the subsequent reassembly contained in chapter 3, section VIII are also applicable to DS and GS level maintenance operations.

b. This section contains repair procedures applicable only to DS and GS level maintenance operations.

c. Illustrations showing major assembly, PCB, and component locations are provided in figure 4-23.

4-17. Heat sink assemblies (fig 4-24 through fig 4-27).

a. Disassembly.

(1) Verify that the electrical power toggle switch, located on the back panel of the ES apparatus, is at the "O" symbol. Also verify that the electrical power cord is disconnected from the electrical receptacle.

(2) Remove the four slotted screws and lockwashers fastening the top cover of the ES apparatus. Set them aside.

(3) Remove the top cover by gently rocking it back and forth while simultaneously pulling it upward. Set it aside.

(4) Remove the slotted screws fastening the two plastic cable clamps to the plastic electronics cover.

(5) Remove the four slotted screws fastening the plastic electronics cover to the heat sinks. Set them aside.

(6) Pull the plastic electronics cover out to the side below the cable assemblies. Set it aside.

(7) Disconnect the following electronic plugs. (Refer back to figures 4-14 and 4-15.)

(a) P800 from J200

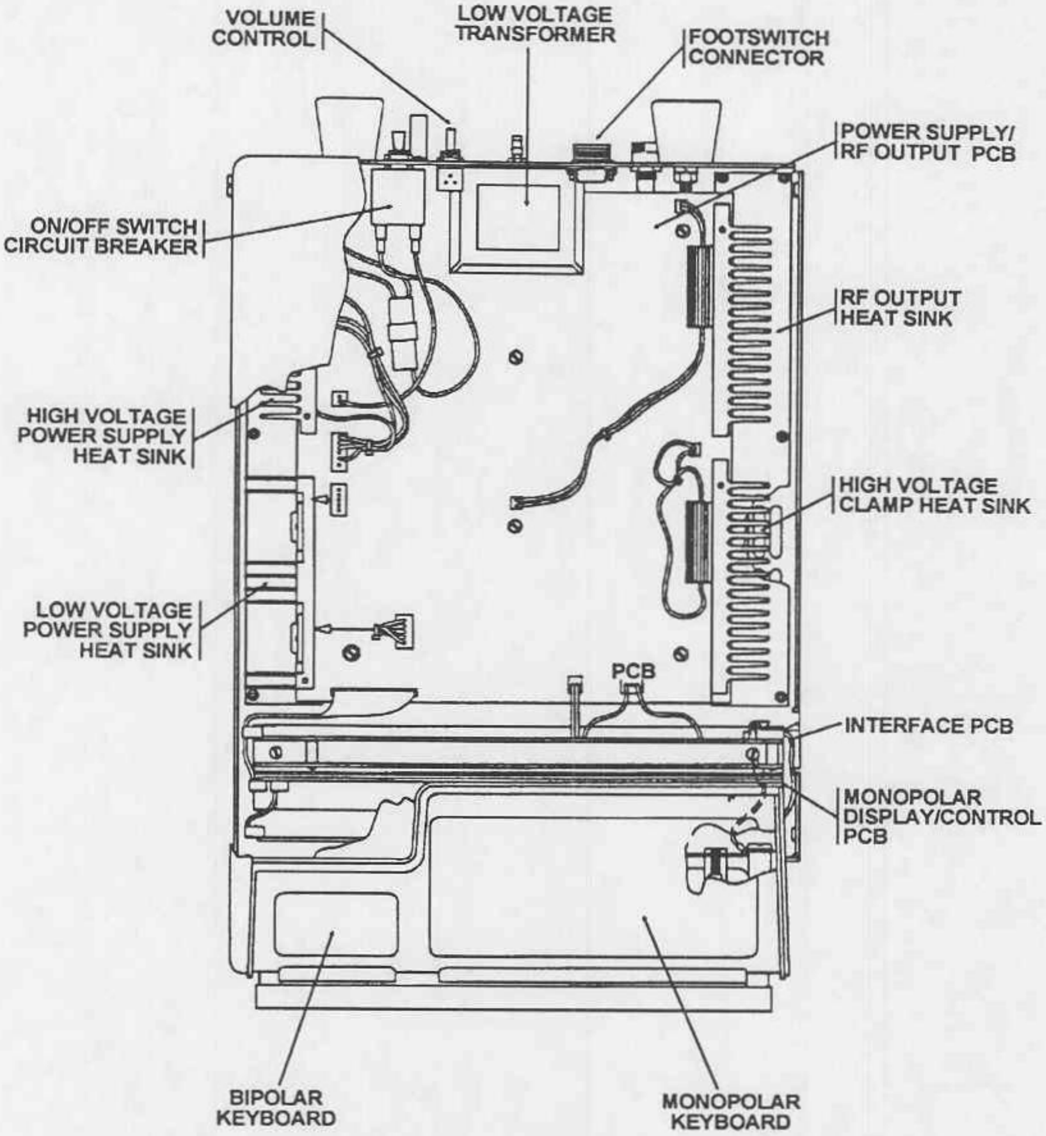

VOLUME CONTROL
LOW VOLTAGE TRANSFORMER
FOOTSWITCH CONNECTOR
POWER SUPPLY/ RF OUTPUT PCB
ON/OFF SWITCH CIRCUIT BREAKER
RF OUTPUT HEAT SINK
HIGH VOLTAGE POWER SUPPLY HEAT SINK
HIGH VOLTAGE CLAMP HEAT SINK
LOW VOLTAGE POWER SUPPLY HEAT SINK
PCB
INTERFACE PCB
MONOPOLAR DISPLAY/CONTROL PCB
BIPOLAR KEYBOARD
MONOPOLAR KEYBOARD

Figure 4-23. Assembly, PCB, and component locations.

(b) P801 from J201
(c) P702 from J202
(d) P1103 from J203
(e) P1114 from J314
(f) P1106 from J206
(g) P1115 from J315
(h) P204 from J304
(i) P205 from J305
(j) P1116 from J316
(k) P1108 from J208
(l) P1113 from J313
(m) P1112 from J312

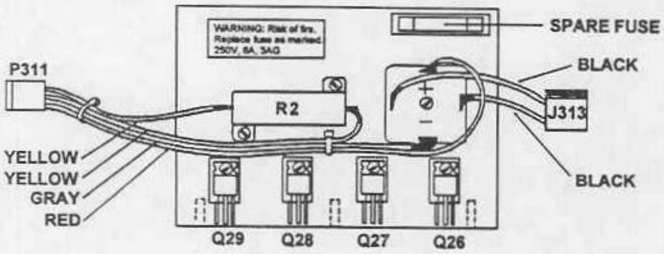

WARNING: Risk of fire.
Replace fuse as marked.
250V, 8A, 3AG
SPARE FUSE
BLACK
P311
R2
J313
YELLOW
YELLOW
GRAY
RED
BLACK
Q29
Q28
Q27
Q26

Figure 4-24. Heat sink assembly, power supply.

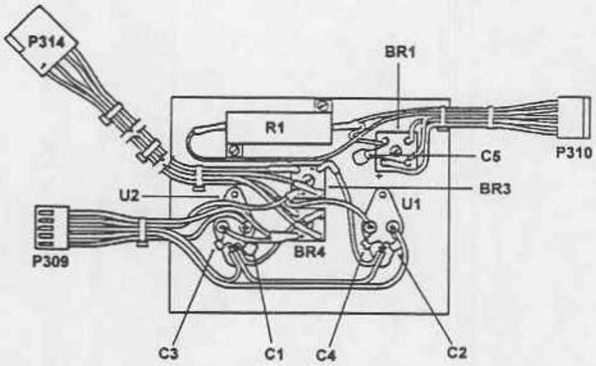

P314
BR1
R1
P310
C5
BR3
U2
U1
P309
BR4
C3
C1
C4
C2

Figure 4-25. Heat sink assembly, low voltage PS.

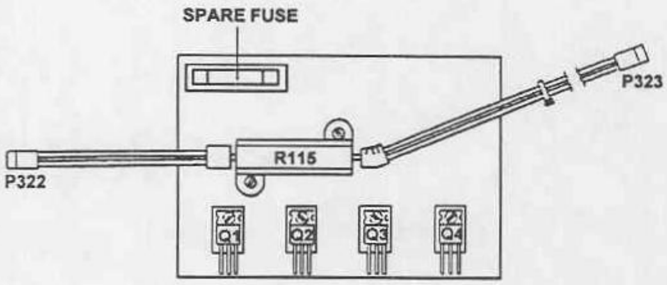

SPARE FUSE
P323
R115
P322
Q1
Q2
Q3
Q4

Figure 4-26. Heat sink assembly, RF output.

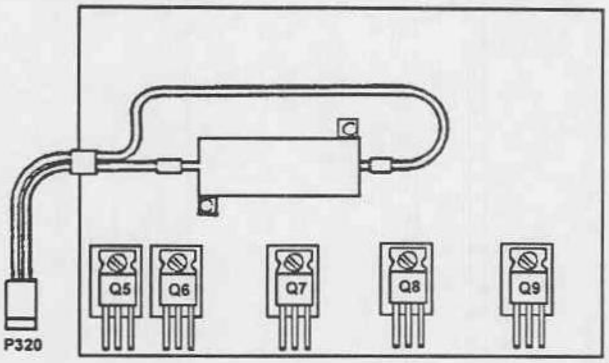

Q5
Q6
Q7
Q8
Q9
P320

Figure 4-27. Heat sink assembly, electronic clamp.

(8) Remove the two slotted screws fastening the interface assembly to the base assembly. Set them aside.

NOTE

Removal of the screw from the right-hand side of the interface assembly will free the short green/yellow electrical ground wire assembly. Set it aside.

(9) Remove the interface assembly from the base assembly. Set it aside.

(10) Remove the six slotted screws and five insulating plastic washers fastening the PSRF PCB to the base assembly.

NOTE

The slotted mounting screw located in the left-hand front position uses a crimped metal lockwasher to connect the PCB to the base assembly for an electrical ground.

(11) Lift out the PSRF PCB using extreme caution and place it upside down.

(12) Disconnect the electronic plug(s), identified in figures 4-24 through 4-27, from the specific heat sink(s) you need to remove.

(13) Remove the three slotted screws fastening the specific heat sink assembly you need to remove. Set them aside.

(14) Gently pull the heat sink assembly from the PSRF PCB.

CAUTION

Do not rock a heat sink assembly from side-to-side to prevent damage to components.

b. Maintenance services.

(1) Replace components as required.

(2) Proceed with electronic component installation and mounting guidelines and requirements as follows:

(a) All non-polarized components will be installed in such a manner so that the value, tolerance, and part number are visible.

(b) Polarized components will be installed so that the positive symbol (+), negative symbol (-), or other polarization markings are visible.

(c) Components with a coating on the leads will have that coating removed only to the point where that lead enters the component body.

(d) The body of a component will be centered between bends. The leads, where required, will be formed to line up with the mounting holes prior to installation.

NOTE

The cathode lead of some miniature diodes should be longer than the anode lead to assist in identification.

(e) Lead-mounted components will be positioned so that the major axis of the component is parallel to any two of the three major planes (sides) of the ES apparatus.

(f) Components weighing over 0.5 ounce shall be mechanically supported by a means other than the leads.

(g) All component leads which could be become shorted with another lead, or component, shall be insulated.

(h) Component leads will not be stressed between mounting points. Adequate strain relief will be provided to prevent damage to the component and solder joints.

(i) Components with metallic bodies installed on the circuitry side of PCBs will have insulated sleeving.

(j) Heat sink assembly components will be coated with thermal compound prior to mounting.

(k) Resistors of two watts or less shall be mounted flush to the PCB.

(l) Resistors of three watts or more shall be mounted 0.25 ±0.06 inch (0.635 ±0.15 cm) from the PCB surface to the resistor body.

(m) Radial-lead capacitors will be bent no closer to the body than 0.06 inch (0.15 cm) and mounted 0.032 inch (0.08 cm) to 0.25 inch (0.635 cm) from the PCB surface to the capacitor body.

(n) Surfaces to be soldered shall be clean and free of contaminates to prevent poor soldering.

(o) Solder temperatures shall be closely controlled to prevent damage to the components or circuitry.

(p) Flux residue shall be removed from PCB surfaces after soldering.

c. Reassembly.

(1) Position the repair or replacement heat sink assembly onto the PSRF PCB and reinstall the three slotted screws and lockwashers to fasten it.

(2) Position the PSRF PCB into the base assembly.

(3) Reconnect the electronic plug(s) to the specific heat sink(s) you removed in the disassembly.

(4) Reinstall the six slotted mounting screws and five insulating plastic washers to refasten the PCB.

CAUTION

Ensure that the crimped metal lockwasher is used in the left-hand front position.

(5) Reconnect the following electronic plugs. (Refer back to figures 4-14 and 4-15.)

(a) P800 to J200
(b) P801 to J201
(c) P702 to J202
(d) P1103 to J203
(e) P1106 to J206
(f) P1116 to J316
(g) P204 to J304
(h) P205 to J305
(i) P1112 to J312
(j) P1113 to J313
(k) P1114 to J314
(l) P1115 to J315
(m) P1108 to J208

(6) Position the interface assembly mounting holes to align with the base assembly mounting holes.

(7) Insert one of the slotted screws into the crimped terminal lug of the green/yellow electrical ground wire assembly and then insert the screw through the mounting holes. Tighten the screw and then reinstall the second screw to fasten the interface assembly to the base assembly.

(8) Position the plastic electronics cover beneath the cable assemblies and align its mounting holes with the screw holes in the heat sinks.

(9) Reinstall the four slotted screws to refasten the plastic electronics cover to the heat sinks.

(10) Reinstall the two slotted screws to refasten the two plastic cable clamps.

(11) Position the top cover of the ES apparatus into place.

(12) Reinstall the four slotted screws and lockwashers to refasten the top cover to the base assembly.

4-18. Watts indicators (fig 4-28).

a. Disassembly.

(1) Verify that the electrical power toggle switch, located on the back panel of the ES apparatus, is at the "O" symbol. Also verify that the electrical power cord is disconnected from the electrical wall receptacle.

(2) Remove the four slotted screws and lockwashers fastening the top cover of the ES apparatus to the base assembly. Set them aside.

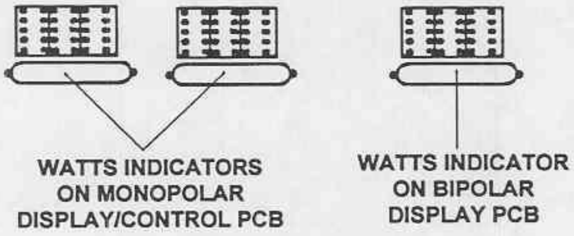


Figure 4-28. Watts indicators.

(3) Remove the top cover by gently rocking it back and forth while simultaneously pulling it upward. Set it aside.

(4) Disconnect the following electronic plugs. (Refer back to figure 4-14.)

(a) P1117 from J117

(b) P800 from J200

(c) P801 from J201

(d) P702 from J202

(e) P1003 from J203

NOTE

A flat blade offset screwdriver is required to remove the slotted screws in the next two steps.

(5) Remove the slotted screw, holding the green/yellow electrical ground wire, with a crimped terminal lug and flat washer, from the right-hand handle rod. Set them aside.

(6) Remove the slotted screw and flat washer from the left-hand handle rod. Set them aside.

(7) Pull out the handle to remove it. Set it aside.

(8) Remove the two slotted screws, located on the bottom of the base assembly, attaching the RF shield bracket to the base assembly. Set them aside.

(9) Remove the three hex socket screws from the lower front of the control panel assembly. Set them aside.

(10) Detach the control panel assembly from the base assembly.

(11) Disconnect P1118 from J118 on the left side of the MD/C PCB.

(12) Turn the control panel assembly upside down with the RF shield facing you.

CAUTION

Rest the control panel assembly on a soft cloth to prevent marring the assembly.

(13) Remove the slotted screw and flat washer from the left side (near the bottom) of the RF shield. Set them aside.

NOTE

A white, plastic standoff will fall free. Set it aside with the slotted screw.

(14) Remove the slotted screw from the lower right-hand corner of the RF shield while holding the shield with your other hand. Remove the shield and set it aside.

(15) Remove the hex-shaped standoff from the upper right side of MD/C PCB. Set it aside.

(16) Remove the three slotted screws from the circuit side of the MD/C PCB.

(17) Lift up the MD/C PCB and disconnect P620 (keyboard ribbon cable) from J120 on the PCB. Set it aside.

NOTE

Proceed to the subsequent maintenance services procedures to replace the WATTS indicator lamp on the MD/C PCB unless access to the BD PCB is required.

(18) Remove the round plastic standoff from the BD PCB. Set it and its slotted mounting screw aside.

(19) Remove the three slotted screws fastening the BD PCB. Set them aside.

(20) Lift up the BD PCB with your one hand and disconnect P521 (keyboard ribbon cable) from J421 on the PCB with your other hand. Set it aside.

b. Maintenance services.

(1) Unsolder the lamp electrical leads from the defective PCB.

(2) Remove the lamp from the baffle assembly.

WARNING

> The tubular lamps will easily shatter and extreme caution should be taken to prevent flying glass and injury.

(3) Remove all lamp debris.

(4) Clean the two mounting holes to allow easy insertion of the replacement lamp electrical leads. If required, carefully enlarge the mounting holes with an appropriate tool.

(5) Solder the lamp electrical leads on the back of the PCB.

c. Reassembly.

NOTE

> Proceed to procedure (5) below if the BD PCB was not removed to replace the watts indicator for "MBP POWER."

(1) Hold the BD PCB with one hand and reconnect P521 (keyboard ribbon cable) to J421 on the PCB with your other hand.

(2) Position the BD PCB into place and reinstall the three slotted screws to refasten it.

(3) Reinstall the round plastic standoff onto the MD/C PCB with its slotted screw.

(4) Connect P620 (keyboard ribbon cable) to J120 on the MD/C PCB.

(5) Position the MD/C PCB into place and reinstall the three slotted screws into the circuit side of the PCB.

(6) Reinstall the hex-shaped standoff into the mounting hole in the upper right side of the MD/C PCB.

(7) Insert the longer slotted screw and flat washer through the mounting hole in the lower left-hand corner of the RF shield and then push the plastic standoff onto the screw. Then, while holding the screw and standoff with your fingers, position the screw into its mounting hole and reinstall the screw.

(8) Position the RF shield into place and reinstall the remaining slotted screw into its mounting hole in the lower right corner of the MD/C PCB.

(9) Turn the control panel assembly upright with the front control panel facing upward.

(10) Connect P1118 to J118 on the left side of the MD/C PCB.

(11) Position the control panel assembly onto the base assembly.

(12) Reinstall the three hex socket screws into the lower front of the control panel assembly to fasten it to the base assembly.

(13) Reinstall the two slotted screws through the base assembly and into the RF shield bracket.

(14) Reinstall the handle.

(15) Reinstall the slotted screw and flat washer into the left-hand handle rod.

(16) Insert the slotted screw through the crimped terminal lug of the green/yellow electrical ground wire and then the flat washer. Reinstall the screw into the right-hand handle rod.

(17) Reconnect the following plugs (Refer back to figure 4-14.)

(a) P1117 to J117

(b) P800 to J200

(c) P801 to J201

(d) P702 to J202

(e) P1103 to J203

(18) Reinstall the top cover and refasten it with the four slotted screws and lockwashers.

APPENDIX A

REFERENCES

A-1. Army regulations.

AR 40-61	Medical Logistics Policies and Procedures
AR 710-2	Supply Policy Below the Wholesale Level
AR 725-50	Requisitioning, Receipt, and Issue System

A-2. Technical manual.

TM-DPSC-6500-RPL	Medical Materiel: Medical Repair Parts Reference List

A-3. Technical bulletins.

TB MED 7	Maintenance Expenditure Limits for Medical Materiel
TB 8-6500-MPL	Mandatory Parts List for Medical Equipment
TB 38-750-2	Maintenance Management Procedures for Medical Equipment
TB 740-10/DLAM 4155.5/AFR 67-43	Quality Control, Depot Storage Standards, Appendix M, Medical Supplies

A-4. Field manual.

FM 21-11	First Aid for Soldiers

A-5. Supply bulletin.

SB 8-75-( )-series	Army Medical Department Supply Information

A-6. Other publications.

(These publications may be obtained from Commander, U.S. Army Medical Materiel Agency, ATTN: SGMMA-M, Frederick, MD 21702-5001.)

Instruction Manual, Electrosurgical Apparatus, Model F2-20 PC MIL, February 1990, Valleylab Inc., 5920 Longbow Drive, Boulder, CO 80301

Service Manual, Electrosurgical Apparatus, Model F2-20, PC MIL, February 1990, Valleylab Inc., 5920 Longbow Drive, Boulder, CO 80301

APPENDIX B

MAINTENANCE ALLOCATION CHART

Section I. INTRODUCTION

B-1. General.

a. This section provides a general explanation of all maintenance and repair functions authorized at various maintenance levels.

b. Section II designates overall responsibility for the performance of maintenance functions on the identified end item or component. The implementation of the maintenance functions upon the end item or component will be consistent with the assigned maintenance levels.

c. Section III lists the tools and test equipment required for each maintenance function as referenced from section II.

d. Section IV contains supplemental instructions, explanatory notes, and/or illustrations required for a particular maintenance function.

B-2. Explanation of columns in section II.

a. Group Number, Column 1. The assembly group number (Group No.) column is a numerical group assigned to each assembly. The applicable assembly groups are listed in the maintenance allocation chart (MAC) in disassembly sequence beginning with the first assembly removed in a top down disassembly sequence.

b. Assembly Group, Column 2. This column contains a brief description of the components of each assembly group.

c. Maintenance Functions, Column 3. This column lists the various maintenance functions (A through K) and indicates the lowest maintenance level authorized to perform these functions. The symbol designations for the various maintenance levels are as follows:

C - Operator or crew
O - Unit maintenance
F - Direct support maintenance
H - General support maintenance
D - Depot maintenance

The maintenance functions are defined as follows:

A - Inspect. To determine serviceability of an item by comparing its physical, mechanical, and electrical characteristics with established standards.

B - Test. To verify serviceability and to detect electrical or mechanical failure by use of test equipment.

C - Service. To clean, to preserve, to charge, and to add lubricants, cooling agents, and air. If it is desired that elements, such as painting and lubricating, be defined separately, they may be so listed.

D - Adjust. To rectify to the extent necessary to bring into proper operating range.

E - Align. To adjust specified variable elements of an item to bring it to optimum performance.

F - Calibrate. To determine the corrections to be made in the readings of instruments or test equipment used in precise measurement. Consists of the comparison of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared with the certified standard.

G - Install. To set for use in an operational environment such as tents or International Standards Organization shelters.

H - Replace. To replace unserviceable items with serviceable like items.

I - Repair. Those maintenance operations necessary to restore an item to serviceable condition through correction of material damage to a specific failure. Repair may be accomplished at each level of maintenance.

J - Overhaul. Normally the highest degree of maintenance performed by the Army in order to minimize time work in process consistent with quality and economy of operation. It consists of that maintenance necessary to restore an item to completely serviceable condition as prescribed by a maintenance standard in technical publications for each item of equipment. Overhaul normally does not return an item to like new condition.

K - Rebuild. The highest degree of material maintenance. It consists of restoring equipment as nearly as possible to new condition in accordance with original manufacturing standards. Rebuild is performed only when required by operational considerations or other paramount factors and then only at the depot maintenance level.

d. Tools and Equipment, Column 4. This column is provided for referencing by code, the tools and test equipment (sec III) required to perform the maintenance functions.

e. Remarks, Column 5. This column is provided for referencing by code, the remarks (sec IV) pertinent to the maintenance functions.

B-3. Explanation of columns in section III.

a. Reference Code, Column 1. This column correlates to section II, column 4.

b. Maintenance Level, Column 2. This column identifies the maintenance levels using the tools and test equipment.

c. Nomenclature, Column 3. This column identifies the tools and test equipment.

d. National Stock Number, Column 4. This column provides the national stock number of the specific tools or test equipment.

B-4. Explanation of columns in section IV.

a. Reference Code, Column 1. This column correlates to section II, column 5.

b. Remarks, Column 2. This column provides supplemental information or explanatory notes pertinent to the maintenance function in section II.

Section II. MAINTENANCE ALLOCATION CHART FOR ELECTROSURGICAL APPARATUS

(1) GROUP NO.	(2) ASSEMBLY GROUP	(3) MAINTENANCE FUNCTIONS											(4) TOOLS AND EQUIPMENT	(5) REMARKS
		A	B	C	D	E	F	G	H	I	J	K		
00	ES Apparatus	O 0.6	O 1.2	O 0.5			O 2.1		O 1.4	O 1.6	F 4.0	D 12.5	01,02,03, 04,05,06, 07,08,	A, B
01	Control Panel Assembly												01,02,03, 04,05,06, 07,08,09, 10	A, B
	Monopolar Display/ Control PCB	O 0.4		O 0.1					O 0.5	F 0.7	F 1.5	D 2.2		
	Bipolar Display PCB	O 0.3		O 0.1					O 0.4	F 0.5	F 1.1	D 1.6		
	Monopolar Keyboard		O 0.4						O 1.0					
	Bipolar Keyboard		O 0.3						O 0.8					
	Control Panel Lens	O 0.2							O 0.8					
	Watts Indicator		O 0.4						F 1.8					
	Receptacles		O 0.4						O 1.0	O 0.6				
02	Main Chassis												01,02,03, 04,05,06 07,08,09 10	A, B
	Interface PCB	O 0.4		O 0.1					O 0.5	F 0.8	F 1.6	D 2.3		
	Power Supply/RF PCB	O 0.6		O 0.2					O 0.8	F 1.2	F 2.2	D 3.4		

Section II. MAINTENANCE ALLOCATION CHART FOR ELECTROSURGICAL APPARATUS

(1) GROUP NO.	(2) ASSEMBLY GROUP	(3) MAINTENANCE FUNCTIONS											(4) TOOLS AND EQUIPMENT	(5) REMARKS
		A	B	C	D	E	F	G	H	I	J	K		
	Fuse		O 0.1						O 0.2					
	Heat Sinks		O 0.4						F 1.0	F 1.4	F 2.1			
	Power Transformer		O 0.4						F 1.2	F 1.0				
03	Monopolar Footswitch		O 0.3		O 0.4				O 0.1	O 0.6	F 1.0		01,02,03, 04,05	A, B
04	Bipolar Footswitch		O 0.2		O 0.3				O 0.1	O 0.5	F 0.9		01,02,03, 04,05	A, B
05	Mobile Cart	O 0.2							O 0.2	O 0.4			01,02,03	A
06	Shipping/Storing Chest	O 0.2							O 0.2	O 1.2		D 2.2	01,02,03	A
07	Canvas Case	O 0.2							O 0.2	O 0.6			01,02,03	A

Section III. TOOLS AND TEST EQUIPMENT FOR ELECTROSURGICAL APPARATUS

(1) REFERENCE CODE	(2) MAINTENANCE LEVEL	(3) NOMENCLATURE	(4) NATIONAL STOCK NUMBER
01	O,F,H,D	Tool Kit, Medical Equipment Maintenance and Repair: Repairmans	5180-00-611-7923
02	O,F,H,D	Tool Kit, Medical Equipment Maintenance and Repair: Organizational	5180-00-611-7924
03	F,H	Shop Equipment, Medical Maintenance: Depot (MEDSOM) Maintenance	4940-00-594-6455
04	O,F,H,D	Multimeter, AN/USM 486	6625-01-145-2430
		or	
		Multimeter, AN/PSM 45A	6625-01-265-6000
05	O,F,H,D	Tester, Current Leakage, TS 2514/P	6625-01-142-8233
06	O,F,H,D	Oscilloscope, AN/USM 488	6525-01-187-7847
		or	
		Oscilloscope, OS262 (P)/U w/Amplifier, Dual Trace, AM 6785/U w/Time Base, Dual Trace, TD1159/U	6625-01-007-9416 6625-00-361-5318 6625-00-261-5139
		or	
		Oscilloscope, OS291/G	6625-01-258-0022
07	O,F,H,D	Tester, Semiconductor, TS 1836 D/U	6625-00-138-7320
08	O,F,H,D	Generator, Signal, SG1171A/U	6625-01-216-9684
		or	
		Generator, Signal, 1288	6625-01-276-9421
09	O,F,H,D	Counter, Electronic, Digital, AN/USM 459	6625-01-271-3012
10	O,F,H,D	Test Set, Electrosurgical Apparatus, TS 4122/P	6625-01-042-8213

Section IV. REMARKS FOR ELECTROSURGICAL APPARATUS

(1) REFERENCE CODE	(2) REMARKS
A	Tools and test equipment are listed for each assembly group.
B	Perform an annual electrical safety inspection and test. Perform the inspection and test after repair or replacement of electrical/electronic components.

APPENDIX C

COMPONENTS OF END ITEM AND BASIC ISSUE ITEMS LIST

Section I. INTRODUCTION

C-1. Scope.

This appendix lists components of end item and basic issue items for the equipment to help you inventory items required for safe and efficient operation.

C-2. General.

The Components of End Item and Basic Issue Items lists are divided into the following sections.

a. Section II. Components of End Item. These items are part of the end item, but are removed and separately packaged for transportation or shipment. As part of the end item, these items must be with the end item whenever it is issued or transferred between property accounts.

b. Section III. Basic Issue Items. These are the minimum essential items required to place the equipment in operation, to operate it, and to perform emergency repairs. Basic issue items must be with the equipment during operation and whenever it is transferred between property accounts. This manual is your authority to request or requisition basic issue items, based on MTOE authorization of the end item.

C-3. Explanation of columns.

The following provides an explanation of columns found in both listings:

a. Item Number, Column 1. This column indicates the item number assigned to the item.

b. National Stock Number, Column 2. This column indicates the national stock number assigned to the item.

c. Description, Column 3. This column indicates the federal item name and, if required, a minimum description to identify and locate the item. The last line for each item indicates the commercial and government entity (CAGE) code in parentheses followed by the part number.

d. Unit of Measure, Column 4. This column indicates the unit of measure used in performing the actual operational or maintenance function. This measure is expressed by a two-character alphabetical abbreviation. These abbreviations are listed in the glossary.

e. Quantity, Column 5. This column indicates the quantity (QTY) of the item(s) provided with the equipment.

Section II. COMPONENTS OF END ITEM FOR ELECTROSURGICAL APPARATUS

(1) ITEM NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
1		Mobile Cart (52385) E8006	EA	1
2	6515-01-328-2275	Switch, Foot (Monopolar Footswitch) (52385) E6008	EA	1
3		Bipolar Footswitch (52385) E6009	EA	1
4		Case, Medical (Canvas Case) (*) AP7705	EA	1
5		Case, Medical (Shipping/Storing Chest) (*) AP7705	EA	1

* Advanced Packaging, Inc. Baltimore, Maryland

Section III. BASIC ISSUE ITEMS FOR ELECTROSURGICAL APPARATUS

(1) ITEM NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
1		Electrode, Coagulation, Ball, 7/32 in (52385) E1002	EA	1
2		Electrode, Needle, 3/4 in (52385) E1003	EA	1
3		Electrode, Straight, Skin Incision Blade, 1 in (52385) E1001	EA	16
4		Electrode, Angled, Coagulation, Ball, 3/32 in (52385) E1004	EA	1
5		Electrode, Cutting and Biopsy Loop, 3/8 in (52385) E1005	EA	1
6		Forceps, Straight Tip, Handswitching, Reusable, 4-3/4 in (52385) E4086	EA	1
7		Surgical Handle and Cable Assembly (52385) E2003	EA	1
8		Forceps, Straight Tip, Handswitching, Reusable, 7 in (52385) E4087	EA	1
9		Cable Assembly, Handswitching Forceps (52385) E0018	EA	1
10	6515-01-096-0217	Handle and Electrode (Pencil Handswitching, Reusable) (52385) E2502B	EA	1
11	6515-01-109-8537	Electrode Gel (52385) E5501	EA	13
12	6515-01-158-8493	Electrode, Electronic Medical Apparatus (Patient Return Electrode) (52385) E7506	EA	12
13	6515-01-229-2662	Electrode, Cautery (Pencil, Handswitching, Disposable) (52385) E2515	EA	1
14		Patient Return Electrode (52385) E7001-1R	EA	1

Section III. BASIC ISSUE ITEMS FOR ELECTROSURGICAL APPARATUS

(1) ITEM NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
15		Cable Assembly, Patient Return Electrode (52385) 0009-1R	EA	1
16		Manual, Instruction (52385) 945-110-052A	EA	2
17		Manual, Service (52385) 945 100 117 A	EA	2

APPENDIX D

EXPENDABLE AND DURABLE SUPPLIES AND MATERIALS LIST

Section I. INTRODUCTION

D-1. Scope.

This appendix lists expendable and durable supplies and materials that are required to maintain the equipment. This listing is authorization to requisition and retain the items if not otherwise authorized.

D-2. Explanation of columns.

a. Item Number, Column 1. The item number (Item No.) is sequentially assigned.

b. Level, Column 2. This column identifies the lowest level of maintenance that requires the listed item. An explanation of the alphabetical character is provided in appendix B, section I of this manual.

c. National Stock Number, Column 3. This column indicates the national stock number assigned to the item.

d. Description, Column 4. This column indicates the federal item name and, if required, a minimum description to identify and locate the item. The last line for each item indicates the CAGE code in parentheses followed by the part number.

e. Unit of Measure, Column 5. This column indicates the unit of measure used in performing the actual operational or maintenance function. This measure is expressed by an alphabetical abbreviation. These abbreviations are listed in the glossary.

f. Quantity, Column 6. This column indicates the quantity (QTY) of the item(s) provided with the equipment.

Section II. EXPENDABLE AND DURABLE SUPPLIES AND MATERIALS LIST FOR ELECTROSURGICAL APPARATUS

(1) ITEM NO.	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) DESCRIPTION	(5) UNIT OF MEASURE	(6) QTY
1	O	7920-01-004-7847	Cloth, Cleaning (97327) Rymple Cloth 301	RO	1
2	O	4940-01-087-3458	Workstation, ESD Control (12038) 4560901 or	EA	1
		4940-01-250-4236	Workstation, ESD Control (81349) MIL-W-87893-30 or	EA	1
		5920-01-253-5368	Workstation, ESD Control (12038) ASGK-MIL	EA	1
3	O	5970-00-419-4290	Tape, Insulation, Electrical (81349) MIL-I-24391	RO	1
4	F	5970-00-152-3887	Insulating Compound (Heat Sink) (13103) 249	TU	1
5	O	8030-01-104-5392	Sealing Compound	BT	1

APPENDIX E

REPAIR PARTS AND SPECIAL TOOLS LIST

Section I. INTRODUCTION

E-1. Scope.

This manual lists spare and repair parts, special tools, special test equipment; and other special support equipment required for the performance of unit level, direct support, general support, and depot level maintenance. It authorizes the requisitioning and issue of spare and repair parts in consonance with the MAC (app B).

E-2. General.

The Repair Parts and Special Tools List is divided into the following sections:

a. Repair Parts, Section II. A list of repair parts authorized for the performance of maintenance in figure number and item number sequence.

b. Special Tools, Test, and Support Equipment, Section III. A list of special tools, test, and support equipment authorized for the performance of maintenance.

E-3. Explanation of columns in section II.

a. Illustration, Column 1.

(1) *Figure Number.* This column indicates the figure number (FIG NO.) of the illustration on which the item is shown.

(2) *Item Number.* This column indicates the item number (ITEM NO.) used to identify each item on the illustration.

b. National Stock Number, Column 2. This column indicates the national stock number assigned to the item.

c. Description, Column 3. This column indicates the federal item name of the item. The last line for each item indicates the CAGE code in parentheses followed by the part number.

d. Unit of Measure, Column 4. This column indicates the unit of measure used in performing the actual operational or maintenance function. This measure is expressed by a two-character alphabetical abbreviation.

e. Quantity, Column 5. This column indicates the quantity (QTY) of the item(s) to be used with or on the illustrated component, assembly, module, or end item.

E-4. Explanation of columns in section III.

a. Item Number, Column 1. This number is sequentially assigned.

b. Level, Column 2. This column identifies the lowest level of maintenance that requires the listed item. An explanation of the alphabetical character is provided in appendix B, section I of this manual.

c. National Stock Number, Column 3. This column indicates the national stock number assigned to the item.

d. Description, Column 4. This column indicates the federal item name and, if required, a minimum description to identify and locate the item. The last line for each item indicates the CAGE code in parentheses followed by the part number.

e. Unit of Measure, Column 5. This column indicates the unit of measure used in performing the actual operational or maintenance function. This measure is expressed by a two-character alphabetical abbreviation.

f. Quantity, Column 6. This column indicates the quantity (QTY) of the item(s) to be used with or on the equipment.

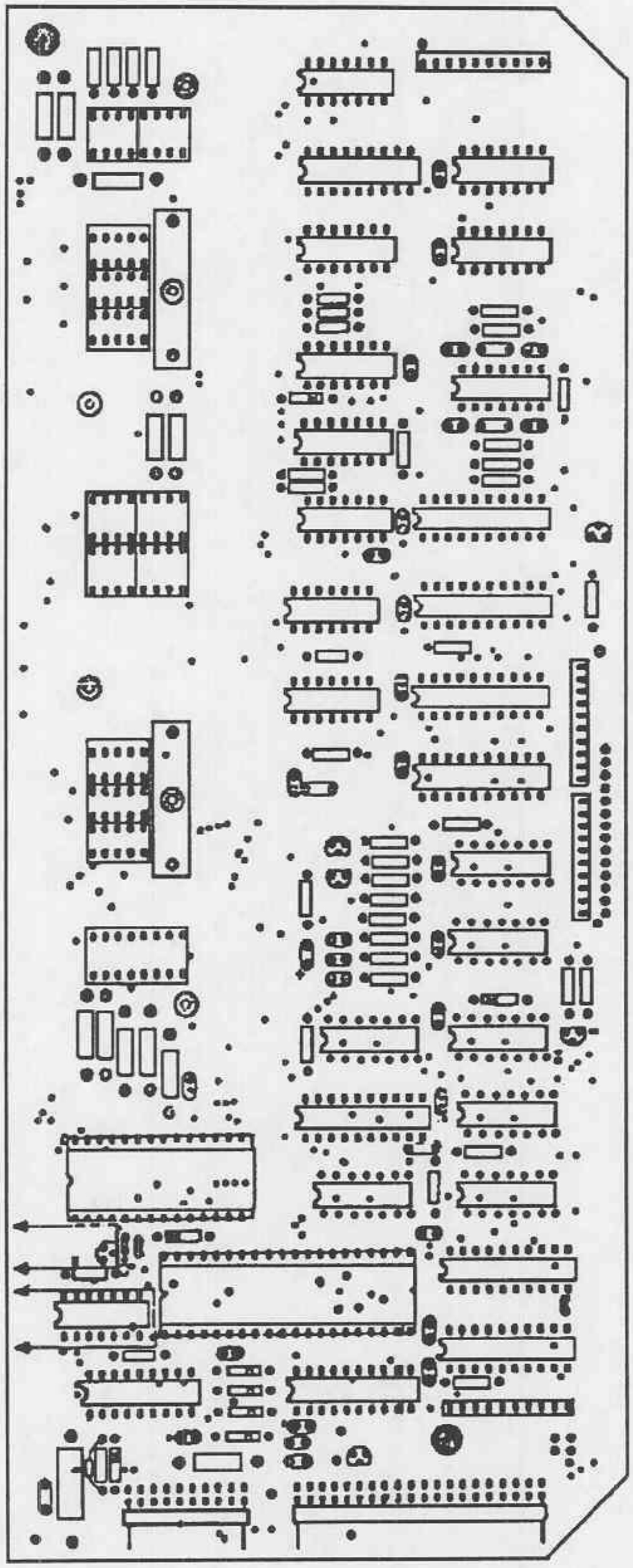


Figure E-1. Monopolar display/control PCB.

Section II. REPAIR PARTS LIST FOR ELECTROSURGICAL APPARATUS

(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-1	1	5999-01-319-6669	Monopolar Display/Control PCB (52385) 201 200 200	EA	1
			Resistors		
E-1	2		R1, 100 ohm ±5%, 1 W (52385) 234 022 039	EA	1
E-1	3		R2, 3.3 k ohm ±5%, ¼ W (52385) 234 024 075	EA	1
E-1	4		R3, 75 ohm ±5%, ½ W (52385) 234 014 086	EA	1
E-1	5		R4, 75 ohm ±5%, ½ W (52385) 234 014 086	EA	1
E-1	6		R5, 27ohm ±5%, ½ W (52385) 234 014 077	EA	1
E-1	7		R6, 75 ohm ±5%, ½ W (52385) 234 014 086	EA	1
E-1	8		R7, 75 ohm ±5%, ½ W (52385) 234 014 086	EA	1
E-1	9		R9, 51 ohm ±5%, ½ W (52385) 234 014 083	EA	1
E-1	10		R10, 18 ohm ±5%, ½ W (52385) 234 014 073	EA	1
E-1	11		R11, 51 ohm ±5%, ½ W (52385) 234 014 083	EA	1
E-1	12		R12, 51 ohm ±5%, ½ W (52385) 234 014 083	EA	1
E-1	13		R13, 51 ohm ±5%, ½ W (52385) 234 014 083	EA	1
E-1	14		R14, 3.3 k ohm ±5%, ¼ W (52385) 234 024 075	EA	1
E-1	15		R15, 330 ohm ±5%, ¼ W (52385) 234 024 051	EA	1
E-1	16		R16, 330 ohm ±5%, ¼ W (52385) 234 024 051	EA	1
E-1	17		R17, 3.3 k ohm ±5%, ¼ W (52385) 234 024 075	EA	1

Section II. REPAIR PARTS LIST FOR ELECTROSURGICAL APPARATUS

(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-1	18		R18, 33 ohm ±5%, ½ W (52385) 234 014 078	EA	1
E-1	19		R19, 100 k ohm ±5%, ¼ W (52385) 234 024 111	EA	1
E-1	20		R20, 1 k ohm ±5%, ¼ W (52385) 234 024 063	EA	1
E-1	21		R21, 100 ohm ±5%, ¼ W (52385) 234 024 039	EA	1
E-1	22		R22, 3.3 k ohm ±5%, ¼ W (52385) 234 024 075	EA	1
E-1	23		R23, 10 k ohm ±5%, ¼ W (52385) 234 024 087	EA	1
E-1	24		R24, 4.7 k ohm ±5%, ¼ W (52385) 234 024 079	EA	1
E-1	25		R25, 1 k ohm ±5%, ¼ W (52385) 234 024 063	EA	1
E-1	26		R26, 330 ohm ±5%, ¼ W (52385) 234 024 051	EA	1
E-1	27		R27, 510 ohm ±5%, ¼ W (52385) 234 024 056	EA	1
E-1	28		R28, 1 M ohm ±5%, ¼ W (52385) 234 024 135	EA	1
E-1	29		R29, 100 k ohm ±5%, ¼ W (52385) 234 024 111	EA	1
E-1	30		R30, 100 k ohm ±5%, ¼ W (52385) 234 024 111	EA	1
E-1	31		R31, 130 k ohm ±5%, ¼ W (52385) 234 024 114	EA	1
E-1	32		R32, 10 k ohm ±5%, ¼ W (52385) 234 024 087	EA	1
E-1	33		R33, 3.3 k ohm ±5%, ¼ W (52385) 234 024 075	EA	1
E-1	34		R34, 3.3 k ohm ±5%, ¼ W (52385) 234 024 075	EA	1
E-1	35		R35, 51 ohm ±5%, ¼ W (52385) 234 024 032	EA	1

Section II. REPAIR PARTS LIST FOR ELECTROSURGICAL APPARATUS

(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-1	36		R36, 51 ohm ±5%, ¼ W (52385) 234 024 032	EA	1
E-1	37		R37, 3.3 k ohm ±5%, ¼ W (52385) 234 024 075	EA	1
E-1	38		R38, 33 k ohm ±5%, ¼ W (52385) 234 024 099	EA	1
E-1	39		R39, 1 k ohm ±5%, ¼ W (52385) 234 024 063	EA	1
E-1	40		R40, 24 k ohm ±5%, ¼ W (52385) 234 024 096	EA	1
E-1	41		R41, 10 k ohm ±5%, ¼ W (52385) 234 024 087	EA	1
E-1	42		R42, 10 k ohm ±5%, ¼ W (52385) 234 024 087	EA	1
E-1	43		R43, 20 k ohm ±5%, ¼ W (52385) 234 024 094	EA	1
E-1	44		R44, 10 k ohm ±5%, ¼ W (52385) 234 024 087	EA	1
E-1	45		R45, 10 k ohm ±5%, ¼ W (52385) 234 024 087	EA	1
E-1	46		R46, 10 k ohm ±5%, ¼ W (52385) 234 024 087	EA	1
E-1	47		R47, 100 k ohm ±5%, ¼ W (52385) 234 024 111	EA	1
E-1	48		R48, 100 k ohm ±5%, ¼ W (52385) 234 024 111	EA	1
E-1	49		R49, 1.8 M ohm ±5%, ½ W (52385) 234 024 141	EA	1
E-1	50		R50, 1.8 M ohm ±5%, ½ W (52385) 234 024 141	EA	1
E-1	51		R51, 1 k ohm ±5%, ¼ W (52385) 234 024 063	EA	1
E-1	52		R52, 1 k ohm ±5%, ¼ W (52385) 234 024 063	EA	1
E-1	53		RA1, 1 k ohm ±5%, ½ W (52385) 234 100 134	EA	1

Section II. REPAIR PARTS LIST FOR ELECTROSURGICAL APPARATUS

(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-1	54		RA2, 1 k ohm ±5%, ½ W (52385) 234 100 134	EA	1
E-1	55		RA3, 1 k ohm ±5%, ½ W (52385) 234 100 134	EA	1
E-1	56		RA4, 1 k ohm ±5%, ½ W (52385) 234 100 134	EA	1
			Capacitors		
E-1	57		C1, 1.0 μF ±20%, 50 V (52385) 204 118 014	EA	1
E-1	58		C2, 0.1 μF ±20%, 50 V (52385) 204 118 007	EA	1
E-1	59		C3, 0.1 μF ±20%, 50 V (52385) 204 118 007	EA	1
E-1	60		C4, 10 μF ±20%, 25 V (52385) 204 102 028	EA	1
E-1	61		C5, 10 μF ±20%, 25 V (52385) 204 102 028	EA	1
E-1	62		C6, 1.0 μF±20%, 50 V (52385) 204 118 014	EA	1
E-1	63		C7, 0.1 μF ±20%, 50 V (52385) 204 118 007	EA	1
E-1	64		C8, 10 μF ±20%, 25 V (52385) 204 102 028	EA	1
E-1	65		C9, 0.1 μF ±20%, 50 V (52385) 204 118 007	EA	1
E-1	66		C10, 0.1 μF ±20%, 50 V (52385) 204 118 007	EA	1
E-1	67		C11, 0.033 μF ±20%, 50 V (52385) 204 118 004	EA	1
E-1	68		C12, 0.1 μF ±20%, 50 V (52385) 204 118 007	EA	1
E-1	69		C13, 1.0 μF ±20%, 50 V (52385) 204 118 014	EA	1
E-1	70		C14, 0.01 mF ±20%, 50 V (52385) 204 118 001	EA	1

Section II. REPAIR PARTS LIST FOR ELECTROSURGICAL APPARATUS

(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-1	71		C15, 0.1 µF ±20%, 50 V (52385) 204 118 007	EA	1
E-1	72		C16, 0.1 µF ±20%, 50 V (52385) 204 118 007	EA	1
E-1	73		C17, 0.1 µF ±20%, 50 V (52385) 204 118 007	EA	1
E-1	74		C18, 0.1 µF ±20%, 50 V (52385) 204 118 007	EA	1
E-1	75		C19, 0.1 µF ±20%, 50 V (52385) 204 118 007	EA	1
E-1	76		C20, 0.1 µF ±20%, 50 V (52385) 204 118 007	EA	1
E-1	77		C21, 0.1 µF ±20%, 50 V (52385) 204 118 007	EA	1
E-1	78		C22, 0.1 µF ±20%, 50 V (52385) 204 118 007	EA	1
E-1	79		C23, 0.1 µF ±20%, 50 V (52385) 204 118 007	EA	1
E-1	80		C24, 0.1 µF ±20%, 50 V (52385) 204 118 007	EA	1
E-1	81		C25, 0.01 mF ±20%, 50V (52385) 204 118 001	EA	1
E-1	82		C26, 0.01 mF ±20%, 50V (52385) 204 118 001	EA	1
E-1	83		C27, 0.1 µF ±20%, 50V (52385) 204 118 007	EA	1
E-1	84		C28, 0.1 µF ±20%, 50 V (52385) 204 118 007	EA	1
E-1	85		C29, 0.01 mF ±20%, 50 V (52385) 204 118 001	EA	1
E-1	86		C30, 1.0 µF ±20%, 50 V (52385) 204 118 014	EA	1
E-1	87		C31, 47 pF ±15%, 100 V (52385) 204 200 009	EA	1
E-1	88		C32, 1.0 µF ±20%, 50 V (52385) 204 118 014	EA	1

Section II. REPAIR PARTS LIST FOR ELECTROSURGICAL APPARATUS

(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-1	89		C33, 33 pF ±15%, 100 V (52385) 204 200 007	EA	1
E-1	90		C34, 0.1 mF ±20%, 50 V (52385) 204 118 001	EA	1
E-1	91		C35, 22 pF ±15%, 100 V (52385) 204 200 005	EA	1
E-1	92		C36, 100 pF ±15%, 100 V (52385) 204 200 013	EA	1
E-1	93		C37, 0.1 µF ±20%, 50 V (52385) 204 118 007	EA	1
E-1	94		C38, 100 pF ±15%, 100 V (52385) 204 200 013	EA	1
			Integrated Circuits		
E-1	95		U1, 2803A (52385) 210 800 002	EA	1
E-1	96		U2, 8749, Programmed (52385) 210 730 066	EA	1
E-1	97		U3, ICM7218C (52385) 210 700 001	EA	1
E-1	98		U4, 74LS374 (52385) 210 520 374	EA	1
E-1	99		U5, 74LS165 (52385) 210 520 165	EA	1
E-1	100		U6, 74LS374 (52385) 210 520 374	EA	1
E-1	101		U7, MC14584B (52385) 210 212 106	EA	1
E-1	102		U8, 4001B (52385) 210 210 001	EA	1
E-1	103		U9, 4013B (52385) 210 027 001	EA	1
E-1	104		U10, 4066 (52385) 210 200 022	EA	1
E-1	105		U11, 4073B (52385) 210 210 073	EA	1

Section II. REPAIR PARTS LIST FOR ELECTROSURGICAL APPARATUS

(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-1	106		U12, SN7406 (52385) 210 500 005	EA	1
E-1	107		U13, 4013B (52385) 210 027 001	EA	1
E-1	108		U14, 2803A (52385) 210 800 002	EA	1
E-1	109		U15, 4081 (52385) 210 210 081	EA	1
E-1	110		U16, 74LS240 (52385) 210 520 240	EA	1
E-1	111		U17, 74LS374 (52385) 210 520 374	EA	1
E-1	112		U18, 74LS85 (52385) 210 520 085	EA	1
E-1	113		U19, 74LS85 (52385) 210 520 085	EA	1
E-1	114		U20, 4068B (52385) 210 210 068	EA	1
E-1	115		U21, 4071B (52385) 210 210 071	EA	1
E-1	116		U22, 4011B (52385) 210 210 011	EA	1
E-1	117		U23, 74LS240 (52385) 210 520 240	EA	1
E-1	118		U24, 74LS240 (52385) 210 520 240	EA	1
E-1	119		U25, DAC0832 (52385) 210 075 001	EA	1
E-1	120		U26, DAC0832 (52385) 210 075 001	EA	1
E-1	121		U27, LM324N (52385) 210 022 000	EA	1
E-1	122		U28, 74LS92 (52385) 210 520 092	EA	1
E-1	123		U29, 4081 (52385) 210 210 081	EA	1

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(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-1	124		CR4, M336 (52385) 210 300 016	EA	1
			Transistors		
E-1	125		Q1, 2N2907A (52385) 239 100 012	EA	1
E-1	126		Q2, 2N3904 (52385) 239 015 000	EA	1
E-1	127		Q3, 2N2907A (52385) 239 100 012	EA	1
E-1	128		Q4, 2N3904 (52385) 239 015 000	EA	1
E-1	129		Q5, VN10KM (52385) 239 200 012	EA	1
			Diodes		
E-1	130	5961-01-249-7371	CR1, Semiconductor Device (52385) 239 014 000	EA	1
E-1	131	5961-01-249-7371	CR2, Semiconductor Device (52385) 239 014 000	EA	1
E-1	132	5961-01-249-7371	CR3, Semiconductor Device (52385) 239 014 000	EA	1
E-1	133	5961-01-249-7371	CR6, Semiconductor Device (52385) 239 014 000	EA	1
E-1	134	5961-01-249-7371	CR7, Semiconductor Device (52385) 239 014 000	EA	1
E-1	135	5961-01-249-7371	CR8, Semiconductor Device (52385) 239 014 000	EA	1
E-1	136	5961-01-249-7371	CR9, Semiconductor Device (52385) 239 014 000	EA	1
E-1	137	5961-01-249-7371	CR10, Semiconductor Device (52385) 239 014 000	EA	1
			Light Emitting Diodes		
E-1	138	5980-01-214-1483	D1, HLMP2720 (50434) 239 750 022	EA	1
E-1	139		D2, HDSP7031 (52385) 239 750 029	EA	1

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(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-1	140		D3, HDSP7031 (52385) 239 750 029	EA	1
E-1	141		D4, HDSP7031 (52385) 239 750 029	EA	1
E-1	142		D5, HLMP2755 (52385) 239 750 033	EA	1
E-1	143		D6, HLMP2855 (52385) 239 750 039	EA	1
E-1	144		D7, HLMP2755 (52385) 239 750 033	EA	1
E-1	145		D8, HLMP2755 (52385) 239 750 033	EA	1
E-1	146		D9, HDSP7031 (52385) 239 750 029	EA	1
E-1	147		D10, HDSP7031 (52385) 239 750 029	EA	1
E-1	148		D11, HDSP7031 (52385) 239 750 029	EA	1
E-1	149	5980-01-142-8054	D12, HLMP2655 (50434) 239 750 042	EA	1
E-1	150		D13, HLMP2855 (52385) 239 750 039	EA	1
			Miscellaneous		
E-1	151		Y1, Crystal, 6 MHz (52385) 250 010 005	EA	1
E-1	152		L1, EMI Ferrite Bead (52385) 251 100 090	EA	1
E-1	153		L2, EMI Ferrite Bead (52385) 251 100 090	EA	1
E-1	154		Lamp, PTL 20D/12 (52385) 251 200 070	EA	1

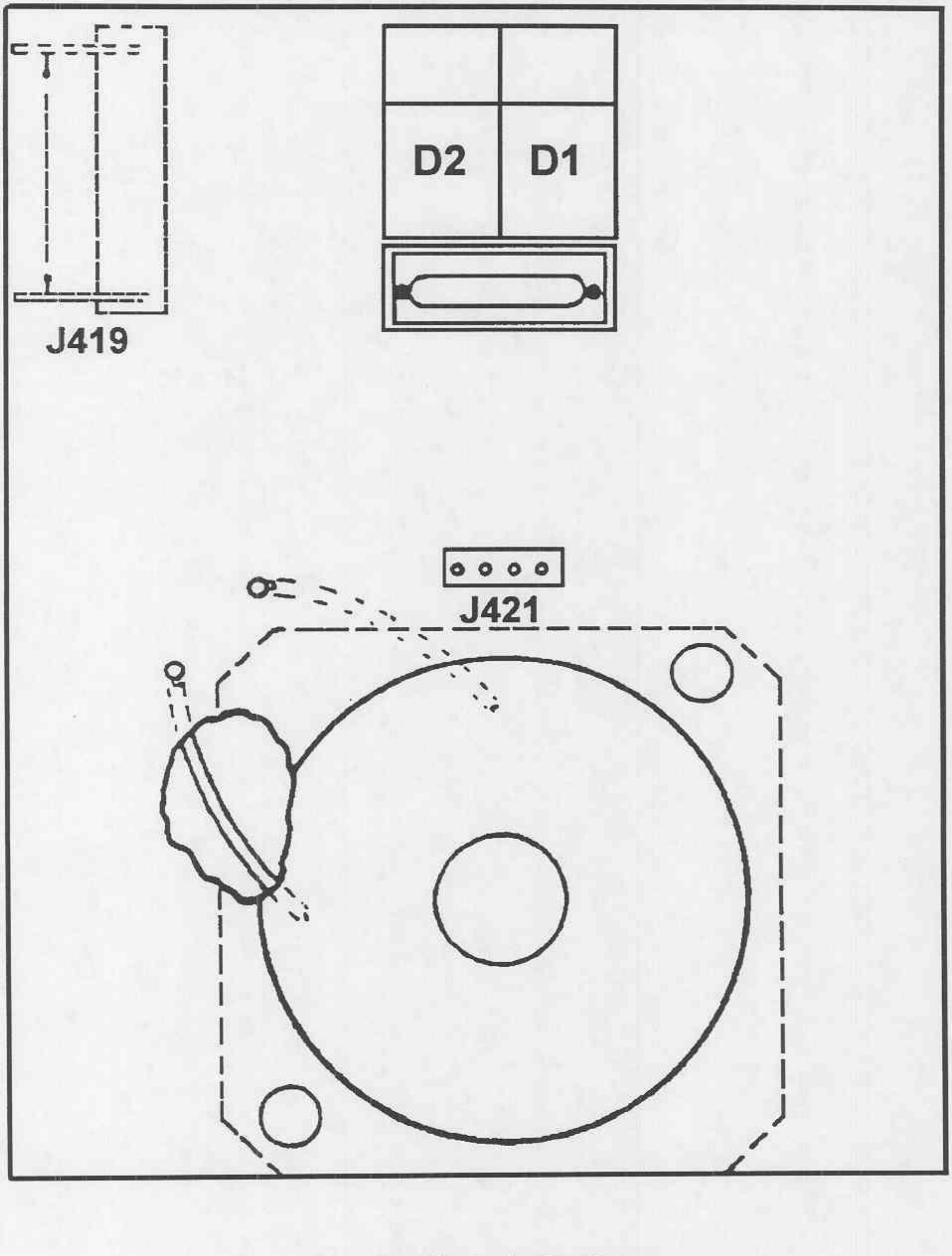
D2
D1
J419
J421

Figure E-2. Bipolar display PCB.

Section II. REPAIR PARTS LIST FOR ELECTROSURGICAL APPARATUS

(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-2	1		Bipolar Display PCB (52385) 201 201 003	EA	1
E-2	2		D1, HDSP7301 (52385) 239 750 029	EA	1
E-2	3		D2, HDSP7301 (52385) 239 750 029	EA	1
E-2	4		Speaker, 8 ohm (52385) 241 003 001	EA	1
E-2	5		Lamp, PTL 6/12 (52385) 215 200 071	EA	1

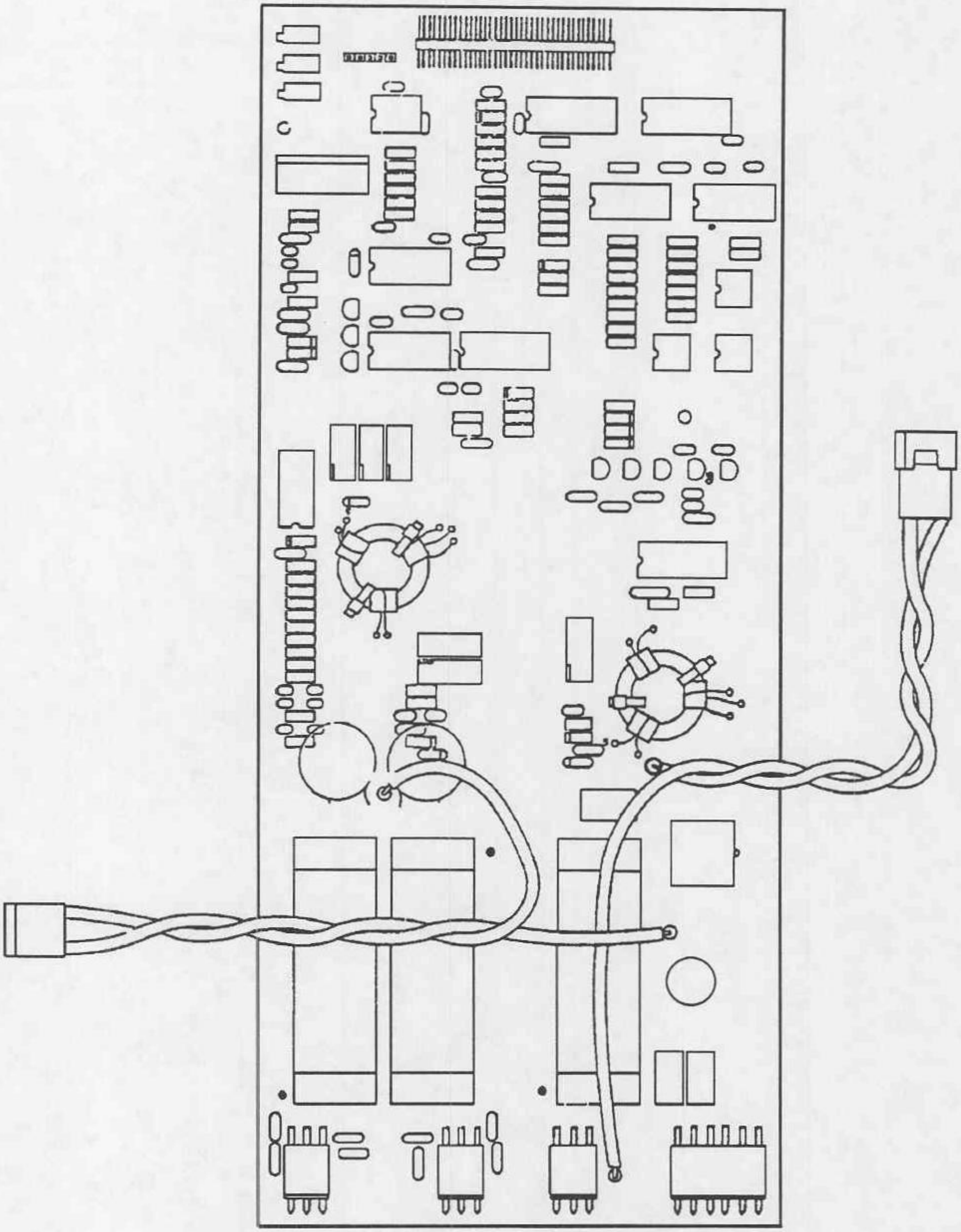

Figure E-3. Interface PCB.

Section II. REPAIR PARTS LIST FOR ELECTROSURGICAL APPARATUS

(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-3	1	5999-01-319-6670	Interface PCB (52385) 201 202 006 A	EA	1
			Resistors		
E-3	2		R201, 10 ohm ±5%, 1/4 W (52385) 234 024 015	EA	1
E-3	3		R202, 1 k ohm ±5%, 1/4 W (52385) 234 024 063	EA	1
E-3	4		R203, 1 k ohm ±5%, 1/4 W (52385) 234 024 063	EA	1
E-3	5		R204, 4.3 k ohm ±5%, 1/4 W (52385) 234 024 078	EA	1
E-3	6		R205, 1 k ohm ±5%, 1/4 W (52385) 234 024 063	EA	1
E-3	7		R206, 1 k ohm ±5%, 1/4 W (52385) 234 024 063	EA	1
E-3	8		R207, 1 k ohm ±5%, 1/4 W (52385) 234 024 063	EA	1
E-3	9		R208, 1 k ohm ±5%, 1/4 W (52385) 234 024 063	EA	1
E-3	10		R209, 3 k ohm ±5%, 1/4 W (52385) 234 024 074	EA	1
E-3	11		R210, 1 k ohm ±5%, 1/4 W (52385) 234 024 063	EA	1
E-3	12		R211, 5.1 k ohm ±5%, 1/4 W (52385) 234 024 080	EA	1
E-3	13		R212, 1 k ohm ±5%, 1/4 W (52385) 234 024 063	EA	1
E-3	14		R213, 1 k ohm ±5%, 1/4 W (52385) 234 024 063	EA	1
E-3	15		R214, 1 k ohm ±5%, 1/4 W (52385) 234 024 063	EA	1
E-3	16		R215, 1 k ohm ±5%, 1/4 W (52385) 234 024 063	EA	1
E-3	17		R216, 11 k ohm ±1%, 1/8 W (52385) 234 201 389	EA	1

Section II. REPAIR PARTS LIST FOR ELECTROSURGICAL APPARATUS

(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-3	18		R217, 51.1 k ohm ±1%, ⅛ W (52385) 234 201 453	EA	1
E-3	19		R218, 3.6 k ohm ±5%, ¼ W (52385) 234 024 076	EA	1
E-3	20		R219, 3.6 k ohm ±5%, ¼ W (52385) 234 024 076	EA	1
E-3	21		R220, 3.6 k ohm ±5%, ¼ W (52385) 234 024 076	EA	1
E-3	22		R221, 3.6 k ohm ±5%, ¼ W (52385) 234 024 076	EA	1
E-3	23		R222, 3.6 k ohm ±5%, ¼ W (52385) 234 024 076	EA	1
E-3	24		R223, 820 k ohm ±5%, ¼ W (52385) 234 024 061	EA	1
E-3	25		R224, 1 k ohm ±5%, ¼ W (52385) 234 024 063	EA	1
E-3	26		R225, 1 k ohm ±5%, ¼ W (52385) 234 024 063	EA	1
E-3	27		R226, 1 k ohm ±5%, ¼ W (52385) 234 024 063	EA	1
E-3	28		R227, 200 k ohm ±5%, ¼ W (52385) 234 024 118	EA	1
E-3	29		R228, 100 k ohm ±5%, ¼ W (52385) 234 024 111	EA	1
E-3	30		R229, 560 k ohm ±5%, ¼ W (52385) 234 024 129	EA	1
E-3	31		R230, 910 k ohm ±5%, ¼ W (52385) 234 024 134	EA	1
E-3	32		R231, 160 k ohm ±5%, ¼ W (52385) 234 024 116	EA	1
E-3	33		R232, 10 k ohm ±5%, ¼ W (52385) 234 024 087	EA	1
E-3	34		R233, 200 k ohm ±1%, ⅛ W (52385) 234 024 510	EA	1
E-3	35		R234, 6.04 k ohm ±1%, ⅛ W (52385) 234 201 364	EA	1

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(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-3	36		R235, 15 k ohm ±5%, ¼ W (52385) 234 024 091	EA	1
E-3	37		R236, 10 k ohm ±1%, ⅛ W (52385) 234 201 385	EA	1
E-3	38		R237, 10 k ohm ±1%, ⅛ W (52385) 234 201 385	EA	1
E-3	39		R238, 15 k ohm ±5%, ¼ W (52385) 234 024 091	EA	1
E-3	40		R239, 200 k ohm ±1%, ⅛ W (52385) 234 024 510	EA	1
E-3	41		R240, 1 k ohm ±5%, ¼ W (52385) 234 024 063	EA	1
E-3	42		R241, 604 k ohm ±1%,⅛ W (52385) 234 201 268	EA	1
E-3	43		R242, 5.1 k ohm ±5%, ¼ W (52385) 234 024 080	EA	1
E-3	44		R244, 10 k ohm ±5%, ¼ W (52385) 234 024 087	EA	1
E-3	45		R245, 3.3 k ohm ±5%, ¼ W (52385) 234 024 075	EA	1
E-3	46		R246, 5.1 k ohm ±5%, ¼ W (52385) 234 024 080	EA	1
E-3	47		R247, 5.1 k ohm ±5%, ¼ W (52385) 234 024 080	EA	1
E-3	48		R248, 390 k ohm ±5%, ¼ W (52385) 234 024 125	EA	1
E-3	49		R249, 10 k ohm ±5%, ¼ W (52385) 234 024 087	EA	1
E-3	50		R250, 19.1 k ohm ±1%, ⅛ W (52385) 234 201 412	EA	1
E-3	51		R251, 10 k ohm ±1%, ⅛ W (52385) 234 201 385	EA	1
E-3	52		R252, 68 k ohm ±5%, ¼ W (52385) 234 024 107	EA	1
E-3	53		R253, 51 k ohm ±5%, ¼ W (52385) 234 024 104	EA	1

Section II. REPAIR PARTS LIST FOR ELECTROSURGICAL APPARATUS

(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-3	54		R254, 820 k ohm ±5%, ¼ W (52385) 234 024 061	EA	1
E-3	55		R255, 820 k ohm ±5%, ¼ W (52385) 234 024 061	EA	1
E-3	56		R256, 820 k ohm ±5%, ¼ W (52385) 234 024 061	EA	1
E-3	57		R257, 820 k ohm ±5%, ¼ W (52385) 234 024 061	EA	1
E-3	58		R258, 820 k ohm ±5%, ¼ W (52385) 234 024 061	EA	1
E-3	59		R259, 470 k ohm ±5%, ¼ W (52385) 234 024 127	EA	1
E-3	60		R260, 10 k ohm ±5%, ¼ W (52385) 234 024 087	EA	1
E-3	61		R261, 100 k ohm ±5%, ¼ W (52385) 234 024 111	EA	1
E-3	62		R262, 10 M ohm ±5%, ¼ W (52385) 234 024 158	EA	1
E-3	63		R263, 33 k ohm ±5%, ¼ W (52385) 234 024 099	EA	1
E-3	64		R264, 2.4 k ohm ±5%, ¼ W (52385) 234 024 072	EA	1
E-3	65		R265, 2.4 k ohm ±5%, ¼ W (52385) 234 024 072	EA	1
E-3	66		R266, 3.6 k ohm ±5%, ¼ W (52385) 234 024 076	EA	1
E-3	67		R267, 15 k ohm ±5%, ¼ W (52385) 234 024 091	EA	1
E-3	68		R268, 5.6 k ohm ±5%, ¼ W (52385) 234 024 081	EA	1
E-3	69		R269, 10 k ohm ±1%, ⅛ W (52385) 234 201 385	EA	1
E-3	70		R270, 887 k ohm ±1%, ⅛ W (52385) 234 201 284	EA	1
E-3	71		R271, 5.6 k ohm ±5%, ¼ W (52385) 234 024 081	EA	1

Section II. REPAIR PARTS LIST FOR ELECTROSURGICAL APPARATUS

(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-3	72		R272, 15 k ohm ±5%, ¼ W (52385) 234 024 091	EA	1
E-3	73		R273, TRIMPOT, 20 k ohm (52385) 236 010 008	EA	1
E-3	74		R274, TRIMPOT, 5 k ohm, #3299X (52385) 236 010 006	EA	1
E-3	75		R275, TRIMPOT, 100 k ohm, #3299X (52385) 236 010 011	EA	1
			Capacitors		
E-3	76		C201, 0.22 μF ±10%, 250 V (52385) 204 400 120	EA	1
E-3	77		C202, 0.22 μF ±10%, 250 V (52385) 204 400 120	EA	1
E-3	78		C203, 0.0047 μF ±20%, 6k V (52385) 204 025 050	EA	1
E-3	79		C204, 0.0047 μF ±20%, 6k V (52385) 204 025 050	EA	1
E-3	80		C205, 0.0047 μF ±20%, 6k V (52385) 204 025 050	EA	1
E-3	81		C206, 0.0047 μF ±20%, 6k V (52385) 204 025 050	EA	1
E-3	82		C207, 0.1 μF ±20%, 50 V (52385) 204 118 007	EA	1
E-3	83		C208, 0.1 μF ±20%, 50 V (52385) 204 118 007	EA	1
E-3	84		C209, 0.1 μF ±20%, 50 V (52385) 204 118 007	EA	1
E-3	85		C210, 0.1 μF ±20%, 50 V (52385) 204 118 007	EA	1
E-3	86		C211, 0.1 μF ±20%, 50 V (52385) 204 118 007	EA	1
E-3	87		C212, 0.1 μF ±20%, 50 V (52385) 204 118 007	EA	1
E-3	88		C213, 1.0 μF ±20%, 50 V (52385) 204 118 014	EA	1

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(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-3	89		C214, 0.1 µF ±20%, 50 V (52385) 204 118 007	EA	1
E-3	90		C215, 0.1 µF ±20%, 50 V (52385) 204 118 007	EA	1
E-3	91		C216, 1.0 µF ±20%, 50 V (52385) 204 118 014	EA	1
E-3	92		C217, 0.1 µF ±20%, 50 V (52385) 204 118 007	EA	1
E-3	93		C218, 240 pF ±5%, 500 V (52385) 204 105 011	EA	1
E-3	94		C219, 1.0 µF ±20%, 50 V (52385) 204 118 014	EA	1
E-3	95		C220, 1.0 µF ±20%, 50 V (52385) 204 118 014	EA	1
E-3	96		C221, 3300 pF (52385) 204 200 031	EA	1
E-3	97		C222, 3300 pF (52385) 204 200 031	EA	1
E-3	98		C223, 1.0 µF ±20%, 50 V (52385) 204 118 014	EA	1
E-3	99		C224, 1.0 µF ±20%, 50 V (52385) 204 118 014	EA	1
E-3	100		C225, 1.0 µF ±20%, 50 V (52385) 204 118 014	EA	1
E-3	101		C226, 1.0 µF ±20%, 50 V (52385) 204 118 014	EA	1
E-3	102		C227, 0.1 µF ±20%, 50 V (52385) 204 118 007	EA	1
E-3	103		C228, 0.1 µF ±20%, 50 V (52385) 204 118 007	EA	1
E-3	104		C229, 0.1 µF ±20%, 50 V (52385) 204 118 007	EA	1
E-3	105		C230, 1.0 µF ±20%, 50 V (52385) 204 118 014	EA	1
E-3	106		C231, 0.01 µF ±15%, 100 V (52385) 204 200 037	EA	1

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(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-3	107		C232, 240 pF ±5%, 500 V (52385) 204 105 011	EA	1
E-3	108		C233, 10 μF ±20%, 25 V (52385) 204 102 028	EA	1
E-3	109		C234, 10 μF ±20%, 25 V (52385) 204 102 028	EA	1
E-3	110		C235, 1.0 μF ±20%, 50 V (52385) 204 118 014	EA	1
E-3	111		C236, 1.0 μF ±20%, 50 V (52385) 204 118 014	EA	1
E-3	112		C237, 10 μF ±20%, 25 V (52385) 204 102 028	EA	1
E-3	113		C238, 0.01 μF ±15%, 100 V (52385) 204 200 037	EA	1
E-3	114		C239, 1.0 μF ±20%, 50 V (52385) 204 118 014	EA	1
E-3	115		C240, 1.0 μF ±20%, 50 V (52385) 204 118 014	EA	1
E-3	116		C241, 1.0 μF ±20%, 50 V (52385) 204 118 014	EA	1
E-3	117		C242, 1.0 μF ±20%, 50 V (52385) 204 118 014	EA	1
E-3	118		C243, 1.0 μF ±20%, 50 V (52385) 204 118 014	EA	1
E-3	119		C244, 1.0 μF ±20%, 50 V (52385) 204 118 014	EA	1
E-3	120		C245, 1.0 μF ±20%, 50 V (52385) 204 118 014	EA	1
E-3	121		C246, 1.0 μF ±20%, 50 V (52385) 204 118 014	EA	1
E-3	122		C247, 0.001 μF ±20%, 50 V (52385) 204 121 060	EA	1
E-3	123		C248, 0.001 μF ±20%, 50 V (52385) 204 121 060	EA	1
E-3	124		C249, 0.001 μF ±20%, 50 V (52385) 204 121 060	EA	1

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(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-3	125		C250, 0.1 μF ±20%, 50 V (52385) 204 118 007	EA	1
E-3	126		C251, 0.1 μF ±20%, 50 V (52385) 204 118 007	EA	1
E-3	127		C252, 0.1 μF ±20%, 50 V (52385) 204 118 007	EA	1
E-3	128		C253, 0.1 μF ±20%, 50 V (52385) 204 118 007	EA	1
E-3	129		C254, 0.1 μF ±20%, 50 V (52385) 204 118 007	EA	1
E-3	130		C255, 0.1 μF ±20%, 50 V (52385) 204 118 007	EA	1
E-3	131		C256, 0.1 μF ±20%, 50 V (52385) 204 118 007	EA	1
E-3	132		C258, 0.1 μF ±20%, 50 V (52385) 204 118 007	EA	1
E-3	133		C259, 0.1 μF ±20%, 50 V (52385) 204 118 007	EA	1
E-3	134		C260, 0.1 μF ±20%, 50 V (52385) 204 118 007	EA	1
E-3	135		C261, 1.0 μF ±20%, 50 V (52385) 204 118 014	EA	1
E-3	136		C262, 1.0 μF ±20%, 50 V (52385) 204 118 014	EA	1
E-3	137		C263, 1.0 μF ±20%, 50 V (52385) 204 118 014	EA	1
E-3	138		C264, 1.0 μF ±20%, 50 V (52385) 204 118 014	EA	1
			Integrated Circuits		
E-3	139	5962-01-249-7326	U201, Microcircuit Linear (52385) 210 300 015	EA	1
E-3	140		U202, 4049B (52385) 210 210 049	EA	1
E-3	141		U203, 179L05AC (52385) 210 300 071	EA	1

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(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-3	142		U204, 4013B (52385) 210 027 001	EA	1
E-3	143		U205, 4049B (52385) 210 210 049	EA	1
E-3	144		U206, 4011B (52385) 210 210 011	EA	1
E-3	145		U207, LM358AN (52385) 210 300 013	EA	1
E-3	146	5962-01-249-7326	U208, Microcircuit Linear (52385) 210 300 015	EA	1
E-3	147		U209, 4066 (52385) 210 200 022	EA	1
E-3	148		U210, 4049B (52385) 210 210 049	EA	1
E-3	149		U211, 4049B (52385) 210 210 049	EA	1
			Transistors		
E-3	150		Q201, 2N3904 (52385) 239 015 000	EA	1
E-3	151		Q202, 2N3904 (52385) 239 015 000	EA	1
E-3	152		Q203, 2N3904 (52385) 239 015 000	EA	1
E-3	153		Q204, VN10KM (52385) 239 200 012	EA	1
E-3	154		Q205, VN10KM (52385) 239 200 012	EA	1
E-3	155		Q206, 2N3904 (52385) 239 015 000	EA	1
E-3	156		Q207, 2N2907A (52385) 239 100 012	EA	1
			Diodes		
E-3	157	5961-01-249-7317	CR 201, Semiconductor Device (52385) 239 014 000	EA	1
E-3	158	5961-01-249-7317	CR 202, Semiconductor Device (52385) 239 014 000	EA	1

Section II. REPAIR PARTS LIST FOR ELECTROSURGICAL APPARATUS

(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-3	159	5961-01-249-7317	CR 203, Semiconductor Device (52385) 239 014 000	EA	1
E-3	160	5961-01-249-7317	CR 204, Semiconductor Device (52385) 239 014 000	EA	1
E-3	161	5961-01-249-7317	CR 205, Semiconductor Device (52385) 239 014 000	EA	1
E-3	162	5961-01-249-7317	CR 206, Semiconductor Device (52385) 239 014 000	EA	1
E-3	163	5961-01-249-7317	CR 207, Semiconductor Device (52385) 239 014 000	EA	1
E-3	164	5961-01-249-7317	CR 208, Semiconductor Device (52385) 239 014 000	EA	1
E-3	165	5961-01-249-7317	CR 209, Semiconductor Device (52385) 239 014 000	EA	1
E-3	166	5961-01-249-7317	CR 210, Semiconductor Device (52385) 239 014 000	EA	1
E-3	167	5961-01-249-7317	CR 211, Semiconductor Device (52385) 239 014 000	EA	1
E-3	168		CR 212, 1N5240B (52385) 239 600 001	EA	1
E-3	169		CR 213, 1N5240B (52385) 239 600 001	EA	1
E-3	170		CR 214, 1N5240B (52385) 239 600 001	EA	1
E-3	171		CR 215, 1N5240B (52385) 239 600 001	EA	1
			Transformers		
E-3	172		T201, Transformer Assembly (52385) 202 900 017	EA	1
E-3	173		T202, Toroid Assembly (52385) 202 224 000	EA	1
E-3	174		T203, Toroid Assembly (52385) 202 224 000	EA	1
			Miscellaneous		
E-3	175	5945-01-319-6629	K1, Reed Relay (52385) 230 006 019	EA	1

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(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-3	176	5945-01-319-6629	K2, Reed Relay (52385) 230 006 019	EA	1
E-3	177	5945-01-319-6629	K3, Reed Relay (52385) 230 006 019	EA	1
E-3	178		OPT201, Optoisolator 1264B (52385) 239 750 019	EA	1
E-3	179		OPT202, Optoisolator 1264B (52385) 239 750 019	EA	1
E-3	180		OPT203, Optoisolator 1264B (52385) 239 750 019	EA	1
E-3	181		OPT204, Optoisolator 1264B (52385) 239 750 019	EA	1
E-3	182		OPT205, Optoisolator 1264B (52385) 239 750 019	EA	1
E-3	183		OPT206, Optoisolator 1264B (52385) 239 750 019	EA	1
E-3	184	5980-01-250-0459	OPT207, Semiconductor Device, Photo (52385) 239 750 002	EA	1
E-3	185	5980-01-250-0459	OPT208, Semiconductor Device, Photo (52385) 239 750 002	EA	1
E-3	186	5980-01-250-0459	OPT209, Semiconductor Device, Photo (52385) 239 750 002	EA	1

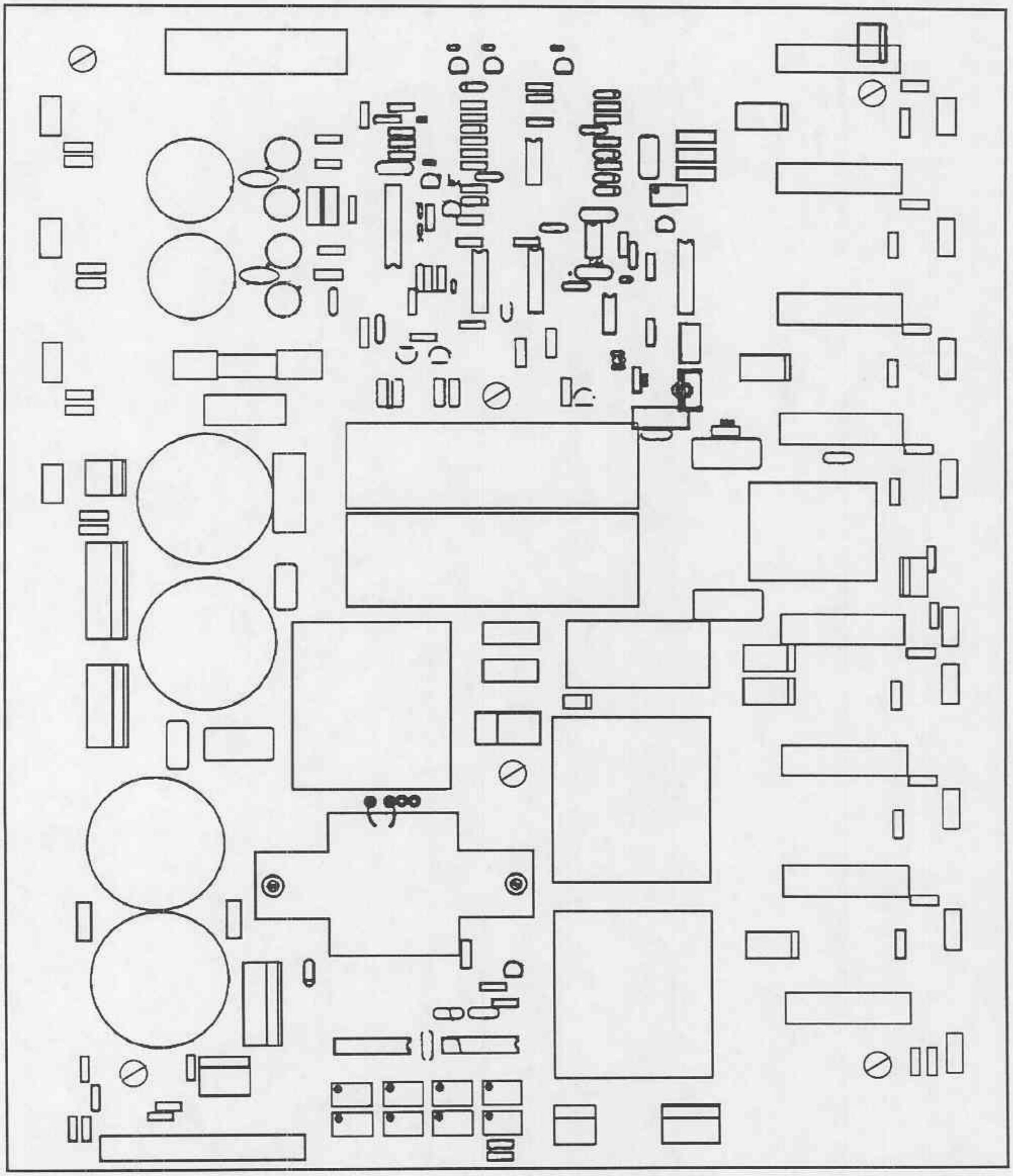

Figure E-4. Power supply/RF PCB.

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(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-4	1	5999-01-319-6668	Power Supply/RF PCB (52385) 201 203 005	EA	1
			Resistors		
E-4	2		R1, Resistor Assembly, 0.2 ohm (52385) 203 077 001	EA	1
E-4	3		R2, 22 ohm ±5%, ¼ W (52385) 234 024 023	EA	1
E-4	4		R3, 1 k ohm ±5%, ¼ W (52385) 234 024 063	EA	1
E-4	5		R4, Resistor Assembly, 0.2 ohm (52385) 203 077 001	EA	1
E-4	6		R5, 22 ohm ±5%, ¼ W (52385) 234 024 023	EA	1
E-4	7		R6, 1 k ohm ±5%, ¼ W (52385) 234 024 063	EA	1
E-4	8		R7, Resistor Assembly, 0.2 ohm (52385) 203 077 001	EA	1
E-4	9		R8, 22 ohm ±5%, ¼ W (52385) 234 024 023	EA	1
E-4	10		R9, 1 k ohm ±5%, ¼ W (52385) 234 024 063	EA	1
E-4	11		R10, Resistor Assembly, 0.2 ohm (52385) 203 077 001	EA	1
E-4	12		R11, 22 ohm ±5%, ¼ W (52385) 234 024 023	EA	1
E-4	13		R12, 1 k ohm ±5%, ¼ W (52385) 234 024 063	EA	1
E-4	14		R13, Foil Inconel, 0.04 ohm (52385) 222 640 001	EA	1
E-4	15		R14, Resistor Assembly, 0.2 ohm (52385) 203 077 001	EA	1
E-4	16		R15, 22 ohm ±5%, ¼ W (52385) 234 024 023	EA	1
E-4	17		R16, 1 k ohm ±5%, ¼ W (52385) 234 024 063	EA	1

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(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-4	18		R17, Resistor Assembly, 0.2 ohm (52385) 203 077 001	EA	1
E-4	19		R18, 22 ohm ±5%, ¼ W (52385) 234 024 023	EA	1
E-4	20		R19, 1 k ohm ±5%, ¼ W (52385) 234 024 063	EA	1
E-4	21		R20, Resistor Assembly, 0.2 ohm (52385) 203 077 001	EA	1
E-4	22		R21, 22 ohm ±5%, ¼ W (52385) 234 024 023	EA	1
E-4	23		R22, 1 k ohm ±5%, ¼ W (52385) 234 024 063	EA	1
E-4	24		R23, Resistor Assembly, 0.2 ohm (52385) 203 077 001	EA	1
E-4	25		R24, 22 ohm ±5%, ¼ W (52385) 234 024 023	EA	1
E-4	26		R25, 1 k ohm ±5%, ¼ W (52385) 234 024 063	EA	1
E-4	27		R26, 120 k ohm ±5%, ½ W (52385) 234 014 124	EA	1
E-4	28		R27, 160 k ohm ±5%, ½ W (52385) 234 014 127	EA	1
E-4	29		R28, 47 k ohm ±5%, ½ W (52385) 234 014 115	EA	1
E-4	30		R29, Trimpot, 1 k ohm (52385) 236 200 076	EA	1
E-4	31		R30, 2 k ohm ±5%, ¼ W (52385) 234 024 070	EA	1
E-4	32		R31, 270 k ohm ±5%, ¼ W (52385) 234 024 049	EA	1
E-4	33		R32, 1 k ohm ±5%, ¼ W (52385) 234 024 063	EA	1
E-4	34		R33, 1 k ohm ±5%, ¼ W (52385) 234 024 063	EA	1
E-4	35		R34, 1.2 k ohm ±5%, ½ W (52385) 234 014 048	EA	1

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(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-4	36		R35, 100 k ohm ±5%, 1/4 W (52385) 234 024 039	EA	1
E-4	37		R36, 51 k ohm ±5%, 1/4 W (52385) 234 024 104	EA	1
E-4	38		R37, 22 k ohm ±5%, 1/4 W (52385) 234 024 079	EA	1
E-4	39		R38, 100 k ohm ±5%, 1/4 W (52385) 234 024 111	EA	1
E-4	40		R39, 4.7 k ohm ±5%, 1/4 W (52385) 234 024 104	EA	1
E-4	41		R40, 5.1 k ohm ±5%, 1/4 W (52385) 234 024 080	EA	1
E-4	42		R41, 300 ohm ±5%, 1/4 W (52385) 234 024 050	EA	1
E-4	43		R43, 1.5 k ohm ±5%, 1/4 W (52385) 234 024 067	EA	1
E-4	44		R44, 1 k ohm ±5%, 1/4 W (52385) 234 024 063	EA	1
E-4	45		R45, 110 k ohm ±5%, 1/4 W (52385) 234 024 112	EA	1
E-4	46		R46, 1 k ohm ±5%, 1/4 W (52385) 234 024 063	EA	1
E-4	47		R47, 4.7 k ohm ±5%, 1/4 W (52385) 234 024 079	EA	1
E-4	48		R48, 560 ohm ±5%, 1/4 W (52385) 234 024 057	EA	1
E-4	49		R49, 330 k ohm ±5%, 1/4 W (52385) 234 024 123	EA	1
E-4	50		R50, 1 k ohm ±5%, 1/4 W (52385) 234 024 063	EA	1
E-4	51		R51, 3.6 k ohm ±5%, 1/4 W (52385) 234 024 076	EA	1
E-4	52		R52, 2.7 k ohm ±5%, 1/4 W (52385) 234 024 073	EA	1
E-4	53		R53, 1.5 k ohm ±5%, 1/4 W (52385) 234 024 067	EA	1

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(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-4	54		R54, 33 k ohm ±5%, ¼ W (52385) 234 024 099	EA	1
E-4	55		R55, 1 k ohm ±5%, ¼ W (52385) 234 024 063	EA	1
E-4	56		R56, 10 k ohm ±5%, ¼ W (52385) 234 024 087	EA	1
E-4	57		R57, 10 k ohm ±5%, ¼ W (52385) 234 024 087	EA	1
E-4	58		R58, 100 k ohm ±5%, ¼ W (52385) 234 024 111	EA	1
E-4	59		R59, 2.7 k ohm ±5%, ¼ W (52385) 234 024 073	EA	1
E-4	60		R60, 7.5 k ohm ±5%, ¼ W (52385) 234 024 084	EA	1
E-4	61		R61, 36 ohm ±5%, ¼ W (52385) 234 024 028	EA	1
E-4	62		R62, 47 k ohm ±5%, ¼ W (52385) 234 024 103	EA	1
E-4	63		R63, 30 k ohm ±5%, ¼ W (52385) 234 024 098	EA	1
E-4	64		R64, 5.1 k ohm ±5%, ¼ W (52385) 234 024 080	EA	1
E-4	65		R65, 100 k ohm ±5%, ¼ W (52385) 234 024 111	EA	1
E-4	66		R66, 1 k ohm ±5%, ¼ W (52385) 234 024 063	EA	1
E-4	67		R67, 1 k ohm ±5%, ¼ W (52385) 234 024 063	EA	1
E-4	68		R68, 10 k ohm ±5%, ¼ W (52385) 234 024 087	EA	1
E-4	69		R69, 10 k ohm ±5%, ¼ W (52385) 234 024 087	EA	1
E-4	70		R70, 1 k ohm ±5%, ¼ W (52385) 234 024 063	EA	1
E-4	71		R71, 150 k ohm ±5%, ¼ W (52385) 234 024 115	EA	1

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(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-4	72		R72, 270 ohm ±5%, ¼ W (52385) 234 024 049	EA	1
E-4	73		R73, 100 k ohm ±5%, ¼ W (52385) 234 024 111	EA	1
E-4	74		R74, 470 ohm ±5%, ¼ W (52385) 234 024 055	EA	1
E-4	75		R75, 560 ohm ±5%, ¼ W (52385) 234 024 057	EA	1
E-4	76		R76, 4.7 ohm ±5%, ½ W (52385) 234 014 060	EA	1
E-4	77		R77, 4.7 ohm ±5%, ½ W (52385) 234 014 060	EA	1
E-4	78		R78, 470 ohm ±5%, ¼ W (52385) 234 024 055	EA	1
E-4	79		R79, 10 k ohm ±5%, ¼ W (52385) 234 024 087	EA	1
E-4	80		R80, 20 k ohm ±5%, 8 W (52385) 234 000 017	EA	1
E-4	81		R81, 20 k ohm ±5%, 8 W (52385) 234 000 017	EA	1
E-4	82		R82, 0.1 ohm ±3%, 3 W (52385) 234 028 001	EA	1
E-4	83		R83, 0.1 ohm ±3%, 3 W (52385) 234 028 001	EA	1
E-4	84		R84, 1 k ohm ±5%, ¼ W (52385) 234 024 063	EA	1
E-4	85		R85, 10 k ohm ±5%, ¼ W (52385) 234 024 087	EA	1
E-4	86		R86, 10 k ohm ±5%, ¼ W (52385) 234 024 087	EA	1
E-4	87		R87, 680 ohm ±5%, ¼ W (52385) 234 024 059	EA	1
E-4	88		R88, TRIMPOT, 10 k ohm (52385) 236 200 079	EA	1
E-4	89		R89, TRIMPOT, 10 k ohm (52385) 236 200 079	EA	1

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(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-4	90		R90, TRIMPOT, 10 k ohm (52385) 236 200 079	EA	1
E-4	91		R91, TRIMPOT, 10 k ohm (52385) 236 200 079	EA	1
E-4	92		R92, TRIMPOT, 10 k ohm (52385) 236 200 079	EA	1
E-4	93		R93, TRIMPOT, 10 k ohm (52385) 236 200 079	EA	1
E-4	94		R94, TRIMPOT, 10 k ohm (52385) 236 200 079	EA	1
E-4	95		R95, TRIMPOT, 10 k ohm (52385) 236 200 079	EA	1
E-4	96		R96, 1 k ohm ±5%, ¼ W (52385) 234 024 063	EA	1
E-4	97		R97, 51 ohm ±5%, ¼ W (52385) 234 024 032	EA	1
E-4	98		R98, 51 ohm ±5%, ¼ W (52385) 234 024 032	EA	1
E-4	99		R99, 1 k ohm ±5%, ¼ W (52385) 234 024 063	EA	1
E-4	100		R100, 1 k ohm ±5%, ¼ W (52385) 234 024 063	EA	1
E-4	101		R101, 51 ohm ±5%, ¼ W (52385) 234 024 032	EA	1
E-4	102		R102, 1 k ohm ±5%, ¼ W (52385) 234 024 063	EA	1
E-4	103		R103, 51 ohm ±5%, ¼ W (52385) 234 024 032	EA	1
E-4	104		R104, 1 k ohm ±5%, ¼ W (52385) 234 024 063	EA	1
E-4	105		R105, 10 k ohm ±5%, ¼ W (52385) 234 024 087	EA	1
E-4	106		R106, 10 k ohm ±5%, ¼ W (52385) 234 024 087	EA	1
E-4	107		R107, 10 k ohm ±5%, ¼ W (52385) 234 024 087	EA	1

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(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-4	108		R110, 100 ohm ±5%, ¼ W (52385) 234 024 039	EA	1
E-4	109		R111, 560 ohm ±5%, ¼ W (52385) 234 024 057	EA	1
E-4	110		R112, 1.2 k ohm ±5%, ½ W (52385) 234 014 041	EA	1
E-4	111		R113, 1.2 k ohm ±5%, ½ W (52385) 234 014 041	EA	1
E-4	112		R114, 100 k ohm ±5%, ¼ W (52385) 234 024 111	EA	1
E-4	113		R117, 1 k ohm ±5%, ¼ W (52385) 234 024 063	EA	1
E-4	114		R118, 1 k ohm ±5%, ¼ W (52385) 234 024 063	EA	1
E-4	115		R119, 1 k ohm ±5%, ¼ W (52385) 234 024 063	EA	1
			Capacitors		
E-4	116		C1, 1.0 µF ±20%, 50 V (52385) 204 118 014	EA	1
E-4	117		C2, 0.015 µF ±10%, 500 V (52385) 204 085 012	EA	1
E-4	118		C3, 0.012 µF ±10%, 500 V (52385) 204 085 010	EA	1
E-4	119		C4, 1500 pF ±10%, 1000 V (52385) 204 079 059	EA	1
E-4	120		C5, 100 pF ±15%, 100 V (52385) 204 200 013	EA	1
E-4	121		C6, 1.0 µF ±20%, 50 V (52385) 204 118 014	EA	1
E-4	122		C7, 1.0 µF ±20%, 50 V (52385) 204 118 014	EA	1
E-4	123		C8, 1500 pF ±10%, 1000 V (52385) 204 079 059	EA	1
E-4	124		C9, 100 pF ±15%, 100 V (52385) 204 200 013	EA	1

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(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-4	125		C10, 0.1 μF ±20%, 50 V (52385) 204 118 007	EA	1
E-4	126		C11, 1.0 μF ±20%, 50 V (52385) 204 118 014	EA	1
E-4	127		C12, 33 pF ±10%, 600 V (52385) 204 200 007	EA	1
E-4	128		C13, 47 pF ±15%, 100 V (52385) 204 200 009	EA	1
E-4	129		C14, 0.033 μF ±20%, 50 V (52385) 204 118 004	EA	1
E-4	130		C15, 0.1 μF ±20%, 50 V (52385) 204 118 007	EA	1
E-4	131		C16, 0.1 μF ±20%, 50 V (52385) 204 118 007	EA	1
E-4	132		C17, 1000 pF ±15%, 100 V (52385) 204 200 025	EA	1
E-4	133		C18, 1.0 μF ±20%, 50 V (52385) 204 118 014	EA	1
E-4	134		C19, 0.033 μF ±20%, 50 V (52385) 204 118 004	EA	1
E-4	135		C20, 2200 pF ±5%, 500 V (52385) 204 105 034	EA	1
E-4	136		C22, 1.0 μF ±20%, 50 V (52385) 204 118 014	EA	1
E-4	137		C23, 1.0 μF ±20%, 50 V (52385) 204 118 014	EA	1
E-4	138		C24, 1.0 μF ±20%, 50 V (52385) 204 118 014	EA	1
E-4	139		C25, 1.0 μF ±20%, 50 V (52385) 204 118 014	EA	1
E-4	140		C26, 1000 μF ±20%, 200 V (52385) 204 500 103	EA	1
E-4	141		C27, 1500 pF ±5%, 500 V (52385) 204 105 030	EA	1
E-4	142		C28, 1000 μF ±20%, 200 V (52385) 204 500 103	EA	1

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(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-4	143		C29, 1 µF ±10%, 250 V (52385) 204 400 138	EA	1
E-4	144		C30, 1200 pF ±5%, 200 V (52385) 204 105 028	EA	1
E-4	145		C31, 6800 µF +30 -10%, 25 V (52385) 204 500 106	EA	1
E-4	146		C32, 4700 µF +30 -10%, 35 V (52385) 204 500 105	EA	1
E-4	147		C33, 0.1 µF ±20%, 50 V (52385) 204 118 007	EA	1
E-4	148		C34, 0.1 µF ±20%, 50 V (52385) 204 118 007	EA	1
E-4	149		C35, 1.0 µF ±20%, 50 V (52385) 204 118 014	EA	1
E-4	150		C36, 15 µF ±10%, 220 V (52385) 204 400 130	EA	1
E-4	151		C37, 15 µF ±10%, 220 V (52385) 204 400 130	EA	1
E-4	152		C38, 2 µF, 400 V (52385) 204 400 001	EA	1
E-4	153		C39, 0.1 µF ±20%, 50 V (52385) 204 118 007	EA	1
E-4	154		C40, 0.1 µF ±20%, 50 V (52385) 204 118 007	EA	1
E-4	155		C42, 0.1 µF ±20%, 50 V (52385) 204 118 007	EA	1
E-4	156		C43, 10 µF ±10%, 20 V (52385) 204 055 002	EA	1
E-4	157		C44, 10 µF ±10%, 20 V (52385) 204 055 002	EA	1
E-4	158		C45, 1.0 µF ±20%, 50 V (52385) 204 118 014	EA	1
E-4	159		C47, 1.0 µF ±20%, 50 V (52385) 204 118 014	EA	1
E-4	160		C48, 1.0 µF ±20%, 50 V (52385) 204 118 014	EA	1

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(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-4	161		C49, 1.0 μF ±20%, 50 V (52385) 204 118 014	EA	1
			Integrated Circuits		
E-4	162		U1, 4050B (52385) 210 210 050	EA	1
E-4	163		U2, ICL7660CPA (52385) 210 300 072	EA	1
E-4	164		U3, LM306 (52385) 210 016 002	EA	1
E-4	165		U4, Microcircuit Linear (52385) 210 300 015	EA	1
E-4	166		U5, 4023B (52385) 210 210 023	EA	1
E-4	167		U6, 4011B (52385) 210 210 011	EA	1
E-4	168		U7, SG3526 (52385) 210 300 062	EA	1
E-4	169		U8, 4066 (52385) 210 200 022	EA	1
E-4	170		U9, 4066 (52385) 210 200 022	EA	1
			Transistors		
E-4	171		Q10, VN10KM (52385) 239 200 012	EA	1
E-4	172		Q12, VN10KM (52385) 239 200 012	EA	1
E-4	173		Q14, VN10KM (52385) 239 200 012	EA	1
E-4	174		Q15, VN10KM (52385) 239 200 012	EA	1
E-4	175		Q16, 2N3904 (52385) 239 015 000	EA	1
E-4	176		Q17, VN10KM (52385) 239 200 012	EA	1
E-4	177		Q18, VN10KM (52385) 239 200 012	EA	1

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(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-4	178		Q19, VN10KM (52385) 239 200 012	EA	1
E-4	179		Q20, VN10KM (52385) 239 200 012	EA	1
E-4	180		Q21, VN10KM (52385) 239 200 012	EA	1
E-4	181		Q22, 2N2905A (52385) 239 019 000	EA	1
E-4	182		Q23, MM3724 (52385) 239 052 000	EA	1
E-4	183		Q24, MM3724 (52385) 239 052 000	EA	1
E-4	184		Q25, 2N2905A (52385) 239 019 000	EA	1
E-4	185		Q30, IRF531 (52385) 239 200 014	EA	1
E-4	186		Q31, IRF9533 (52385) 239 200 015	EA	1
			Diodes		
E-4	187		CR1, MR826 (52385) 239 066 005	EA	1
E-4	188		CR2, MR826 (52385) 239 066 005	EA	1
E-4	189		CR3, MR826 (52385) 239 066 005	EA	1
E-4	190		CR4, MR826 (52385) 239 066 005	EA	1
E-4	191		CR5, MR826 (52385) 239 066 005	EA	1
E-4	192	5961-01-249-7319	CR6, Semiconductor Device, Diode (52385) 239 014 000	EA	1
E-4	193	5961-01-249-7319	CR6, Semiconductor Device, Diode (52385) 239 014 000	EA	1
E-4	194	5961-01-249-7319	CR8, Semiconductor Device, Diode (52385) 239 014 000	EA	1

Section II. REPAIR PARTS LIST FOR ELECTROSURGICAL APPARATUS

(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-4	195		CR9, 1N751A (52385) 239 600 011	EA	1
E-4	196	5961-01-249-7319	CR10, Semiconductor Device, Diode (52385) 239 014 000	EA	1
E-4	197	5961-01-249-7319	CR11, Semiconductor Device, Diode (52385) 239 014 000	EA	1
E-4	198	5961-01-249-7319	CR12, Semiconductor Device, Diode (52385) 239 014 000	EA	1
E-4	199		CR13, 1N5233B (52385) 239 600 000	EA	1
E-4	200	5961-01-249-7319	CR14, Semiconductor Device, Diode (52385) 239 014 000	EA	1
E-4	201	5961-01-249-7319	CR15, Semiconductor Device, Diode (52385) 239 014 000	EA	1
			Miscellaneous		
E-4	202		T1, Transformer, Pulse (52385) 251 200 024	EA	1
E-4	203		T2, Transformer, Pulse (52385) 251 200 024	EA	1
E-4	204		T3, Transformer, Power Switching (52385) 251 200 029	EA	1
E-4	205		T4, Transformer, Output (52385) 251 200 030	EA	1
E-4	206		L1, Inductor, Cut (52385) 251 100 077	EA	1
E-4	207		L2, Inductor, 0.75 mH, #T-0403 (52385) 251 039 000	EA	1
E-4	208	5920-01-319-6623	F1, Fuse, Cartridge (52385) 251 005 039	EA	1
E-4	209	5945-01-319-6631	K1, Relay, Electromagnetic (52385) 230 007 002	EA	1

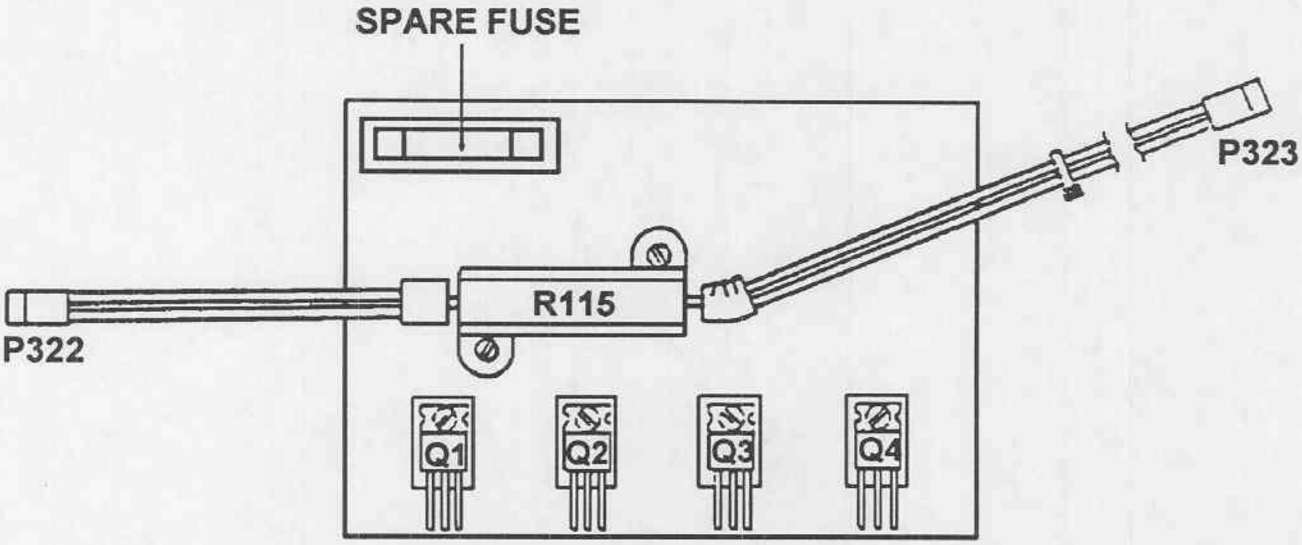
SPARE FUSE
P323
R115
P322
Q1
Q2
Q3
Q4

Figure E-5. Heat sink assembly, RF output.

Section II. REPAIR PARTS LIST
FOR
ELECTROSURGICAL APPARATUS

(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-5	1	5999-01-319-6658	Heat Sink Electrical-Electronic (52385) 202 701 282	EA	1
E-5	2		R115, Resistor, 500 ohm ±5%, 50 W (52385) 234 003 008	EA	1
E-5	3	5961-01-319-6646	Q1, Transistor (52385) 239 200 020	EA	1
E-5	4	5961-01-319-6646	Q2, Transistor (52385) 239 200 020	EA	1
E-5	5	5961-01-319-6646	Q3, Transistor (52385) 239 200 020	EA	1
E-5	6	5961-01-319-6646	Q4, Transistor (52385) 239 200 020	EA	1

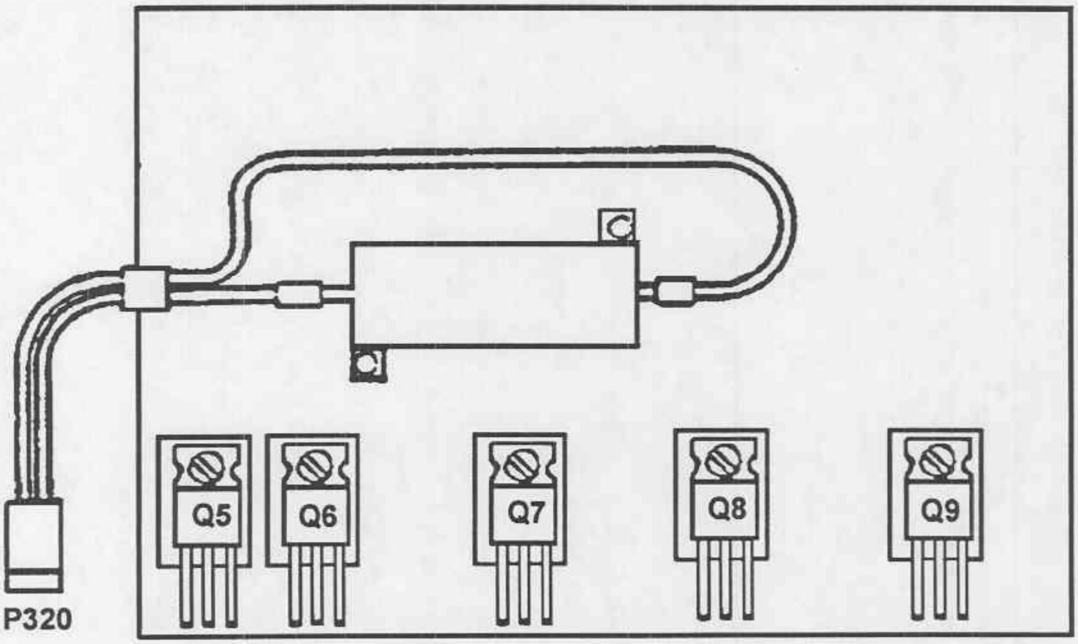
P320
Q5
Q6
Q7
Q8
Q9

Figure E-6. Heat sink assembly, clamp.

Section II. REPAIR PARTS LIST FOR ELECTROSURGICAL APPARATUS

(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-6	1	5999-01-319-6659	Heat Sink Electrical-Electronic (52385) 202 701 283	EA	1
E-6	2		R1, Resistor, 50 ohm ±5%, 50 W (52385) 234 003 007	EA	1
E-6	3	5961-01-319-6646	Q5, Transistor (52385) 239 200 032	EA	1
E-6	4	5961-01-319-6646	Q6, Transistor (52385) 239 200 032	EA	1
E-6	5	5961-01-319-6646	Q7, Transistor (52385) 239 200 032	EA	1
E-6	6	5961-01-319-6646	Q8, Transistor (52385) 239 200 032	EA	1
E-6	7	5961-01-319-6646	Q9, Transistor (52385) 239 200 032	EA	1

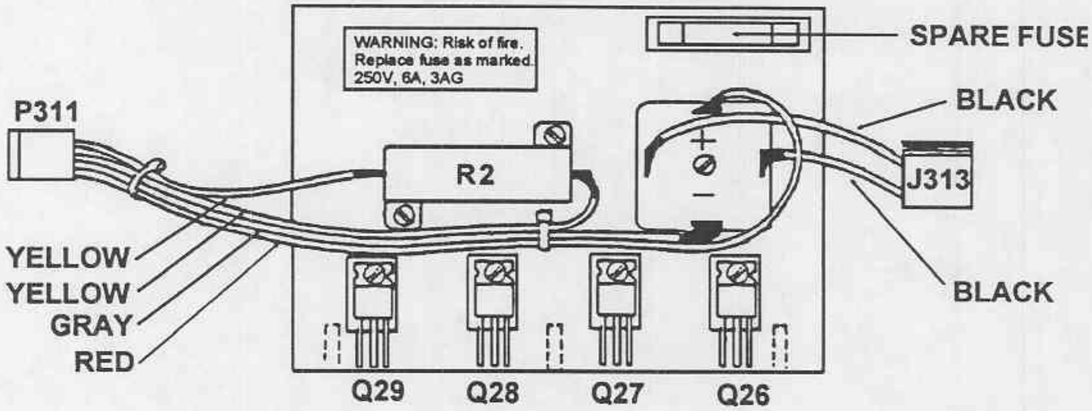
WARNING: Risk of fire.
Replace fuse as marked.
250V, 6A, 3AG
SPARE FUSE
BLACK
P311
R2
J313
YELLOW
YELLOW
GRAY
RED
BLACK
Q29
Q28
Q27
Q26

Figure E-7. Heat sink assembly, power supply.

Section II. REPAIR PARTS LIST FOR ELECTROSURGICAL APPARATUS

(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-7	1	5999-01-319-6660	Heat Sink Electrical-Electronic (52385) 202 701 069	EA	1
E-7	2		R2, Resistor, 50 ohm ±5%, 50 W (52385) 234 003 007	EA	1
E-7	3		Q26,Transistor (52385) 239 200 022	EA	1
E-7	4		Q27, Transistor (52385) 239 200 022	EA	1
E-7	5		Q28, Transistor (52385) 239 200 022	EA	1
E-7	6		Q29, Transistor (52385) 239 200 022	EA	1
E-7	7		BR2, Bridge Rectifier, MDA3504 (52385) 239 700 003	EA	1

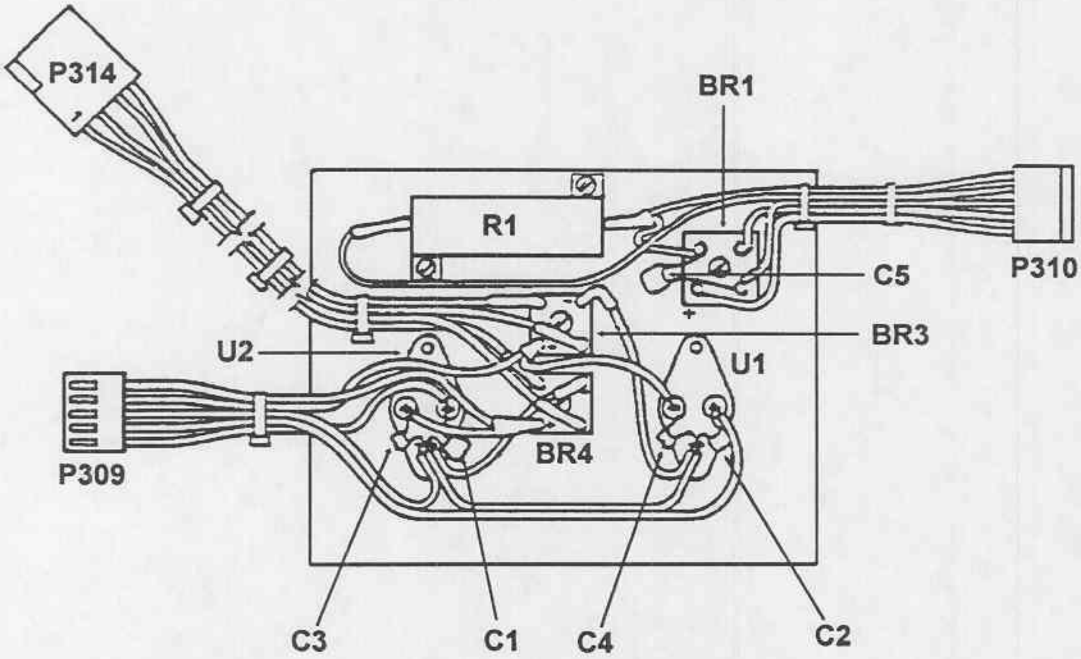
P314
BR1
R1
P310
C5
BR3
U2
U1
P309
BR4
C3
C1
C4
C2

Figure E-8. Heat sink assembly, low voltage PS.

Section II. REPAIR PARTS LIST FOR ELECTROSURGICAL APPARATUS

(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-8	1	5999-01-319-6657	Heat Sink Electrical-Electronic (52385) 202 701 331	EA	1
E-8	2		R1, Resistor, 0.50 ohm ±5%, 50 W (52385) 234 003 005	EA	1
E-8	3		C1, Capacitor, 1.0 μf ±20%, 50 V (52385) 204 118 014	EA	1
E-8	4		C2, Capacitor, 1.0 μf ±20%, 50 V (52385) 204 118 014	EA	1
E-8	5		C3, Capacitor, 1.0 μf ±20%, 50 V (52385) 204 118 014	EA	1
E-8	6		C4, Capacitor, 1.0 μf ±20%, 50 V (52385) 204 118 014	EA	1
E-8	7		C5, 0.0022 μf ±20%, 6 k V (52385) 204 025 044	EA	1
E-8	8		U1, Voltage Regulator, LM340K - 5.0 (52385) 210 300 073	EA	1
E-8	9		U2, Voltage Regulator, LM340K - 12 (52385) 210 300 074	EA	1
E-8	10		BR1, Bridge Rectifier, VK648X (52385) 239 700 034	EA	1
E-8	11		BR3, Bridge Rectifier, VS247 (52385) 239 006 000	EA	1
E-8	12		BR4, Bridge Rectifier, VS247 (52385) 239 006 000	EA	1

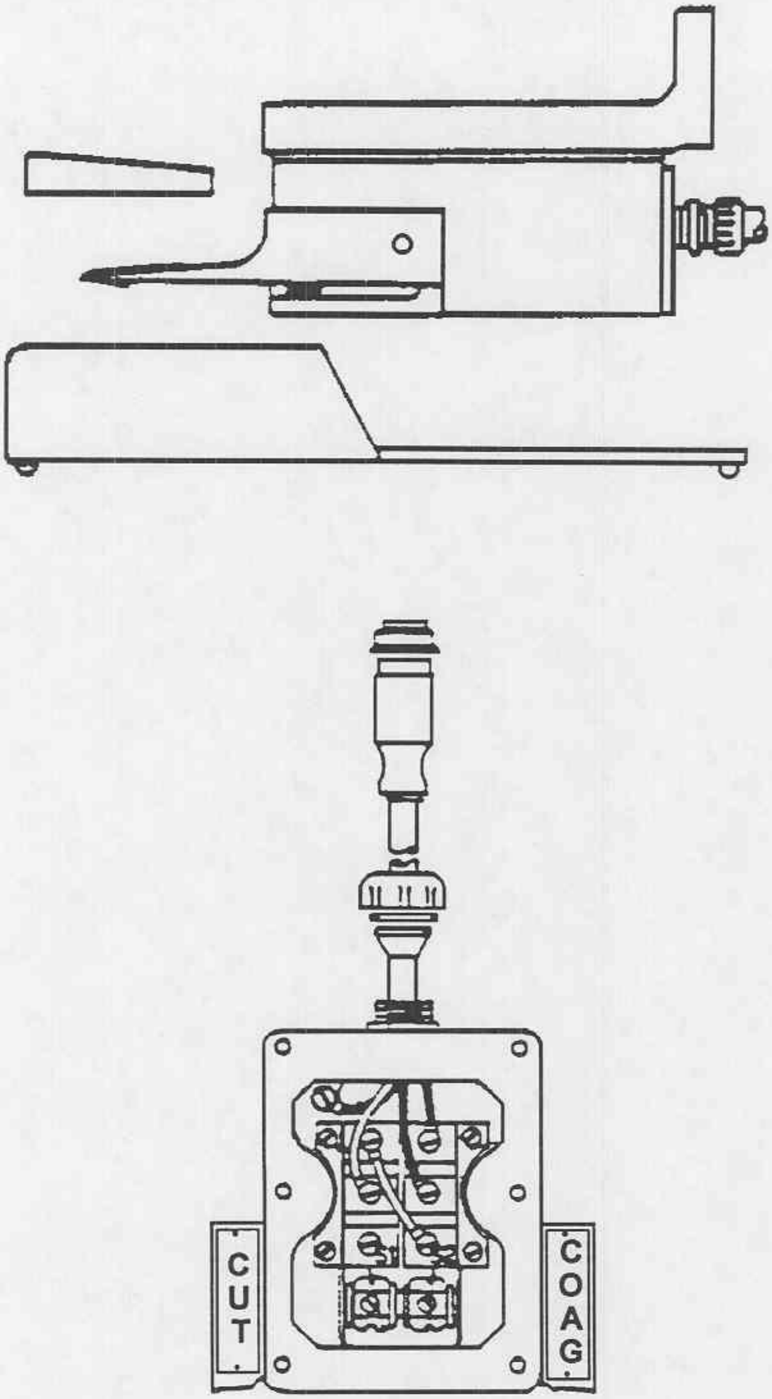

Figure E-9. Monopolar footswitch.

Section II. REPAIR PARTS LIST FOR ELECTROSURGICAL APPARATUS

(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-9	1		Divider Bar (52385) 223 600 009	EA	1
E-9	2		Base (52385) 222 700 000	EA	1
E-9	3		Rubber Feet (52385) 213 110 184	EA	4
E-9	4		Cable Assembly (52385) 202 400 212	EA	1
E-9	5		Strain Relief (52385) 213 150 009	EA	1
E-9	6		CUT Label (52385) 216 100 013	EA	1
E-9	7		COAG Label (52385) 216 100 012	EA	1
E-9	8		Rivets (52385) 237 600 020	EA	2
E-9	9		Switch (52385) 243 068 000	EA	2

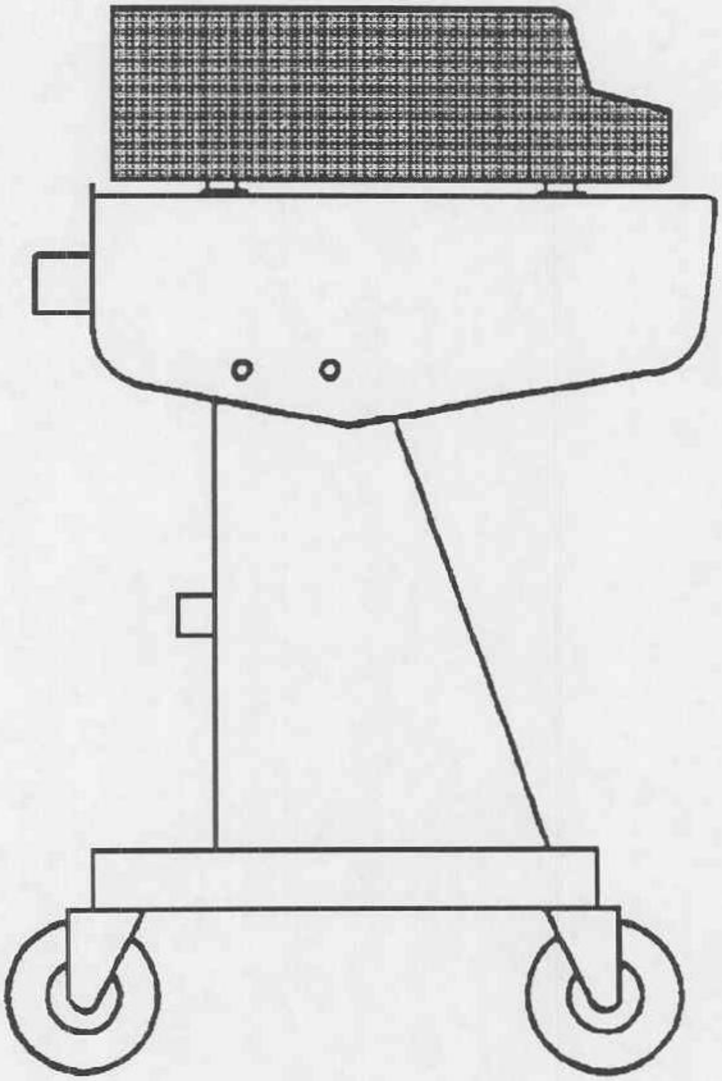

Figure E-10. Mobile cart.

Section II. REPAIR PARTS LIST FOR ELECTROSURGICAL APPARATUS

(1) ILLUSTRATION		(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEASURE	(5) QTY
FIG NO.	ITEM NO.				
E-10	1		Caster 213 200 003	EA	4
E-10	2		Nylon Finger Screw, #8 237 100 552	EA	2
E-10	3		Phillips Screw, #10 237 100 551	EA	6
E-10	4		Wing Nut, #10 224 035 000	EA	6
E-10	5		Fender Washer 253 100 045	EA	2

Section III. SPECIAL TOOLS, TEST, AND SUPPORT EQUIPMENT FOR ELECTROSURGICAL APPARATUS

(1) ITEM NO.	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) DESCRIPTION	(5) UNIT OF MEASURE	(6) QTY
		NO SPECIAL TOOLS, TEST, AND SUPPORT EQUIPMENT ARE APPLICABLE FOR THIS END ITEM.			

GLOSSARY

A	Ampere
AC	Alternating current
AC leakage current	Any 50/60 Hz current, including capacitively - coupled currents, which may be conveyed from accessible parts of the ES apparatus accessories to ground, or through the patient to ground.
Active electrode	The electrical conductor through which a RF current leaves the ES apparatus and enters the patient. An active electrode is typically small in size to provide a high current density to achieve the intended surgical effect.
Adipose	The fat found in human tissue
AFR	Air Force regulation
ALE	Address latch enable
AMP (amp)	Ampere
AND gate	A circuit which has two or more input-signal ports and which delivers an output only if and when every input-signal port is simultaneously energized.
app	Appendix
AR	Army regulation
BCD system format	Binary coded decimal system format
BD	Bipolar display
Bipolar output	An isolated output. See Microbipolar.
BIPSW	Bipolar switch circuit (fig 3-19)
BL1SW	Blend 1 switch (fig 3-19)
BL2SW	Blend 2 switch (fig 3-19)
BL3SW	Blend 3 switch (fig 3-19)
Blend (BL)	An electrosurgical output which is intermediate in crest factor between Cut and Coag. It is best for cutting tissue, while at the same time providing excellent hemostasis. Blend can be thought of of as a "mixture" of Cut and Coag.
BLK	Black
BPDNS	Bipolar down switch circuit (fig 3-20)
BPUPS	Bipolar up switch circuit (fig 3-20)
BT	Bottle
C	Operator or crew
C	Capacitor
CAGE	Commercial and government entity
CGDNS	Coag down switch terminal (fig 3-19)
CGUPS	Coag up switch terminal (fig 3-19)
chap	Chapter
cm	Centimeter

CMOS	Complementary metal oxide semi-conductor
COM	Common electrical point
COAG	Electrocoagulation. To coagulate. The name of the voltage waveform or ES apparatus output that is optimized for the fulguration of tissue.
Coagulate	In electrosurgery, a general term which includes the fulguration and desiccation of tissue. To cause to clot; to achieve hemostasis; to kill tissue with electrosurgery without severing it.
CPU	Central processing unit
CR	Diode
Crest factor	The ratio of the peak voltage to the root mean square (RMS) voltage of a periodic waveform. In electrosurgery, generally the outputs with high waveform crest factors are better for fulgurating tissue.
CTA	Common table of allowances
CTDNS	Cut down switch terminal (fig 3-19)
CTUPS	Cut up switch terminal (fig 3-19)
CUT	In electrosurgery, the name of the voltage waveform or generator output which is optimized for dividing tissue with a minimum of coagulation. An output with a low crest factor, typically 1.4 to 2.0. Tissue division with a fine electrosurgical electrode.
CVC	Calibration/verification/certification
D	Depot level maintenance
DA	Department of the Army
dac	Digital-to-analog converter
dBa	Decibel (adjusted)
DC	Direct current
°C	Degrees Celsius
°F	Degrees Fahrenheit
Desiccation	The dehydration and necrosis of tissue caused by passing a radio frequency electric current through the tissue. In desiccation, the electrodes must be in good electrical contact with the tissue, and the current heats the tissue by dissipating power in the electrical resistance of the tissue. Desiccation differs from fulguration in that there is no sparking between the electrode(s) and the tissue.
DIV	Division
DLA	Defense Logistics Agency
DLAM	Defense Logistics Agency manual
DPSC	Defense Personnel Support Center
DS	Direct support
E	Voltage (electromotive force)
EA	Each
ECON	Power supply control voltage

Electrode	Either terminal of an electric current through which electricity is received or transmitted. In electrosurgery, it is the conductive metal electrode or accessory (such as forceps) which actually contacts the patient's body. In electrosurgery, two electrodes are required and, in monopolar applications, are generally dissimilar in size. The smaller, "active" electrode, is intended to be the site of the electrosurgery, while the larger patient return electrode, merely completes the circuit path back to the ES apparatus.
EMI	Electromagnetic interference
ENT	Head and neck
EPROM	Erasable programmable read-only memory
ES	Electrosurgical
Eschar	A dry scab formed especially as a result of a burn
ESD	Electrostatic discharge
EtO	Ethylene oxide
F	Direct support maintenance
F	Fuse
FET	Field effect transistor
fig (FIG)	Figure
Flip-flop	A multivibrator in which either of two active devices may remain conducting, with the other nonconducting, until the application of an external pulse.
FM	Field manual
FSC	Federal supply class
FSCM	Federal supply code for manufacturers. This is an obsolete term. CAGE (commercial and government entity) is the correct acronym.
ft	Foot (feet)
Fulguration	Coagulating tissue or blood by means of radio frequency electric sparks. In contrast to desiccation, the active electrode is not in good electric contact with the tissue and sparks jump from the electrode to the tissue. Fulguration is literally the reducing of tissue to carbon.
GND	Ground
Ground	Wires and conductors connected to the earth. Grounded conductors all have the same voltage, so no dangerous currents can flow between them.
Ground plate	A patient return electrode which is connected directly to earth ground.
GRN	Green
GS	General support
H	General support maintenance
Hemostatis	The stoppage of a flow of blood
HV	High voltage
HVDC	High voltage direct current
HVPS	High voltage power supply
Hz	Hertz

I	Current
IC	Integrated circuit
ICON	RF current limit analog voltage
Impedance	The resistance to flow of an AC or radio frequency electric current. The term impedance includes not only simple DC resistance, but also the resistance to flow brought about by capacitance and inductance in a circuit.
in	Inch
Integrated circuit (IC)	An interconnected array of active and passive elements integrated with a single semiconductor substrate or deposited on the substrate by a continuous series of compatible processes, and capable of performing at least one complete electronic circuit function.
I/O	Input/Output
Isolated generator output	A generator output which has no reference to ground. In order for current to flow there must be a complete circuit path from the active electrode to the patient return electrode. Isolated outputs are required for good operation with bipolar instruments.
J	Jack
JTA	Joint table of allowances
k	Thousand
kg	Kilograms
kHz	Kilohertz
lbs	Pounds
LED	Light emitting diode
LV	Low voltage
M	Mega (million)
MAC	Maintenance allocation chart
MAN	Manual
mbar	Millibar
MBP	Microbipolar power
MD/C PCB	Monopolar display/control PCB
MEDSOM	Medical supply, optical, and maintenance (battalion)
mF	Millifarad
Mfg	Manufacturer
mH	Millihenry
MHz	Megahertz (1 million)
μA	Microampere
Microbipolar	A term for an isolated, low power ES apparatus output which is optimized for desiccating tissue. Specifically, the microbipolar output is designed for bipolar neurosurgical forceps, bipolar laparoscopic forceps, etc.
μF	Microfarad (one-millionth)
min	Minute

mm	Millimeter
MONSW	Monopolar switch (fig 3-19)
MOSFET	Metal oxide semi-conductor field-effect transistor
MPL	Mandatory parts list
MTOE	Modified table of organization and equipment
NC	Normally closed (switch)
Nibble	A unit of computer storage or information equal to one-half of a byte
NO	Normally open (switch)
NO. (No.)	Number
NOR gate	A circuit in which the output voltage appears only when signals are absent from all input terminals.
NSN	National stock number
O	Unit maintenance
ohm	Measurement of electrical resistance
Op Amp	Operational amplifier. An amplifier having high direct current stability and high immunity to oscillation, generally achieved by using a large amount of negative feedback.
Optoisolator (OPT)	A coupling device in which an LED, energized by the input signal, is optically coupled to a photodetector such as a light-sensitive output diode, transistor, or silicon controlled rectifier.
OR gate	A multiple input gate circuit whose output is energized when any one or more of the input signals is in a prescribed state.
P	Plug
para	Paragraph
Patient return electrode	The electrode at which no electrosurgical effect is intended. It is usually large in area in order to provide a low current density so that no electrosurgical effect occurs at that site. It is also known as a dispersive electrode, patient plate, return electrode, inactive electrode, inert electrode, and indifferent electrode. If actually connected to earth ground, it is also appropriate to call it a "ground plate."
PCB	Printed circuit board
PCTSW	Pure cut switch (fig 3-19)
pF	Picofarad
PMCS	Preventive maintenance checks and services
Port	An entrance or an exit for a electronic network
P-P	Peak to peak (voltage)
psi	Pounds per square inch
PSRF PCB	Power supply/radio frequency output PCB
PURE	A CUT mode with the lowest level of hemostasis.
PWM	Pulse-width modulation. The modulation of a pulse carrier wherein the value of each instantaneous sample of a modulating wave produces a pulse of proportional duration by varying the leading, trailing, or both edges of a pulse.

Q	Energy factor
Q	Transistor
QA	Quality assurance
QC	Quality control
QTY	Quantity
Quad Op Amp	See Op Amp
R	Resistor (resistance)
RA	Resistor array
Radio frequency leakage current	The maximum current which can flow to ground from an isolated generator output when one side of the output is wired directly to earth ground.
R-C	Resistor - capacitor
RDYSW	Ready switch (fig 3-19)
RF	Radio frequency. A high frequency alternating current. "Radio" generally means a frequency greater than 100,000 Hz (cycles/second).
RO	Roll
RPL	Repair parts list
µs	Microsecond (one-millionth)
SB	Supply bulletin
SBYSW	Standby switch (fig 3-19)
sec	Section
Sink leakage current	The maximum current which can flow into a patient connected lead (patient return electrode, active electrode, etc.) when current at 50/60 Hz AC is applied to that patient lead. The lead itself produces no current but passively accepts current flowing to ground when a ground referenced power source (the line voltage) is applied to the patient by accident.
Source leakage current	The maximum 50/60 Hz current which will flow out of the chassis, patient return electrode, or active electrode when touched to a grounded object. In contrast to sink leakage, source leakage is active, that is, it provides a current which could flow through the patient or person touching the generator or accessories.
STDBY	Standby
SW	Switch
T	Transformer
TB	Technical bulletin
TDA	Table of distribution and allowances
TM	Technical manual
TOFF	Turn off
TON	Turn on
TU	Tube
V	Volt(s)
VAC	Volts alternating current

VDC	Volts direct current
Vp	Volts peak
W	Watt(s)
WHT	White
YEL	Yellow

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TM 8-6515-003-24&P	6 Feb 88	Electrosurgical Apparatus, Model Force 2

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E-11		E-6		Reverse call-out numbers 4 and 8. REASON: Correctly identifies part.

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METRIC SYSTEM CONVERSIONS

CHANGE	TO	MULTIPLY	CHANGE	TO	MULTIPLY
inches	centimeters	2.540	centimeters	inches	.394
feet	meters	.305	meters	feet	3.280
yards	meters	.914	meters	yards	1.094
sq inches	sq centimeters	6.451	sq centimeters	sq inches	.155
sq feet	sq meters	.093	sq meters	sq feet	10.764
cubic feet	cubic meters	.028	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29.573	milliliters	fluid ounces	.034
pints	liters	.473	liters	pints	2.113
quarts	liters	.946	liters	quarts	1.057
gallons	liters	3.785	liters	gallons	.264
ounces	grams	28.349	grams	ounces	.035
pounds	kilograms	.454	kilograms	pounds	2.205

TEMPERATURE CONVERSION

Degrees Fahrenheit to Degrees Celsius: (°F - 32) X .5555 = °C

Degrees Celsius to Degrees Fahrenheit: (°C X 1.8) + 32 = °F

WEIGHTS

1 gram = 10 decigrams = .035 ounce

1 dekagram = 10 grams = .35 ounce

1 hectogram = 10 dekagrams = 3.52 ounces

1 kilogram = 10 hectograms = 2.2 pounds

LINEAR MEASURE

1 centimeter = 10 millimeters = .39 inch

1 decimeter = 10 centimeters = 3.94 inches

1 meter = 10 decimeters = 39.37 inches

CUBIC MEASURE

1 cu centimeter = 1000 cu millimeters = .06 cu inch

1 cu decimeter = 1000 cu centimeters = 61.02 cu inches

1 cu meter = 1000 cu decimeters = 35.31 cu feet

LIQUID MEASURE

1 centiliter = 10 milliters = .34 fluid ounce

1 deciliter = 10 centiliters = 3.38 fluid ounces

1 liter = 10 deciliters = 33.81 fluid ounces